AN EXPLORATORY STUDY OF SYMBIOTIC CHANGING RELATIONSHIPS BETWEEN A MAJOR AEROSPACE MANUFACTURER AND THIRTY-FOUR OF ITS COMPONENT SUPPLIERS

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1993

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CERTIFICATE OF ORIGINALITY

I hereby certify that I personally conducted all of the field interviews, literature search, analysis of the data and writing of this dissertation.

I extensively utilised various books, journal articles, and periodicals during the preparation of this dissertation. I attempted to give full credit to authors as appropriate, and hopefully did not plagiarize their thoughts or written words. Transgressions, if any, are purely unintentional and due to ignorance, not intent.

18.10.93

HAROLD D. MORELAND DATE

EXPRESSION OF APPRECIATION

I wish to express my most sincere appreciation to my two supervisors, Professor Simon Coke and Professor David Hatherly, whose patience must have been tested to the limit. They not only guided me through the maze but also were gentlemen and friends during an intense part of my career. I also appreciate Dr. James Livingstone for his early assistance, and Dr. Paul Holmes for being my mentor. And last, but as important, to Phyllis, Ben, Eric and Allegra - just for being there.

DEDICATION OF DISSERTATION

To Mom and Dad, I hope you know...

LIST OF ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS

ABC - Activity Based Costing

BAe - British Aerospace, Plc., the parent corporation of Prestwick

CNC - Computer Numerically Controlled machinery or equipment

JIT - Just-In-Time

LFO - Loose Foreign Object, usually referred to in a manufacturing context, e.g., dropped parts on the shop floor.

MITI - Ministry of International Trade and Industry (Japanese)

Prestwick - civil airlines division of BAe, located at Prestwick, Scotland, major manufacturer used in this research

SME - Small and Medium Sized Enterprise

TQC - Total Quality Control

DEFINITIONS

CAPITAL INTENSIVE - Processes and/or products using a high percentage of capital per unit of output relative to labor.

COMMENSALISM - Two entities involved on the same project and achieving the same goals with no harm to the other. One of the entities may provide the project.

CORPORATE CULTURE - The policies, as perceived by corporate employees, which describes behaviour within an organization; often unwritten and not formally articulated.

CULTURAL CLUSTER - A grouping of nations perceived as culturally similar along some set of dimensions (e.g. language, ethnic origins, degree of industrialisation), which leads to similarities in managerial style.

CULTURAL DISTANCE - The difference of one community or nation from another in terms of language, values, and institutions.

INTERNATIONALISATION - The process by which a corporation brings a global skill or function within its own organisation without regard to political or national boundaries.

LEARNING CURVE - The graphic representation of a company's increasing efficiency as it becomes more skilled. It is a function of volume, time, and the capacity of a firm to capture its own experience.

MUTUALISM - Associations in which mutual advantage is apparent, but without the implication that the partner's are ultimately dependent upon one another in the physiological sense.

SMALL & MEDIUM SIZED ENTERPRISES - Businesses with less than £25 million annual turnover and/or less than 400 employees.

SYMBIOTIC CHANGE - The commensal association between two different sized entities, each of which is currently undergoing specified changes, and both of which receive mutual benefits from their association. The mutual changes are similar or mirror images of each other between the two entities.

VERTICAL CONSISTENCY - The degree to which managers at all levels within an organization use similar styles of decision making.

UNINATIONAL - Involving or operating within the boundaries of one nation. A uninational enterprise is a business established, owned, and operated by the nationals of the country where it is located.

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CHAPTER ONE INDEX - **INTRODUCTION**

CHAPTER ONE - **INTRODUCTION**

'An exploratory study of symbiotic changing relationships between a major aerospace manufacturer and thirty-four of its component suppliers.'

1.0 DISSERTATION INTRODUCTION

"Man has long been peculiarly fascinated by association between animals of different species. Here perhaps we can steer a middle course and define symbiosis as a state of affairs in which organisms live together for mutual benefit in such close relationship that each has lost at least some degree of physiological independence." (Gotto, 1969, p.16.)

Gotto's writing forms the focal point for modifying the natural science definition of symbiosis into a business definition of symbiotic changing relationships between a major manufacturer and its smaller component suppliers.

1.1 Introduction

Western manufacturers are striving to regain their manufacturing preeminence through modernization of their manufacturing facilities, quality assurance and purchasing methodologies. These changes in operating methodologies are noticed and sometimes emulated by the component suppliers to the major manufacturers. The implementation by such Western businesses of changes to meet these strategic threats are affecting the traditional business relationships between major prime manufacturers and their myriad subcontractors and suppliers. The nature of these new relationships raises the question of how the subcontractors react, if at all, to the requirements and changes of their prime manufacturing customers.

Furthermore, as changes are being implemented by both participants, the question arises as to what extent their interactions and relationships are symbiotic.

There is academic and anecdotal evidence suggesting that the changing relationships are leading to greater mutual dependency between the prime manufacturer and their suppliers. This increasing interaction has been explained and analyzed in terms of transaction cost analysis, micro-economic theories, and by the so-called 'Japanization of Western Business' theories. This dissertation addresses the relationship issue in an alternative manner drawing on the natural science discipline of zoology.

The zoological concept of symbiosis, together with commensality and mutual beneficiality, is used to study the phenomenon of growing interdependence discussed above. At its simplest, symbiosis can be seen as the advantage to be gained by both parties in the example of the gleaner fish that lives in the mouth of the shark. The smaller fish feeds off the parasites in the shark's mouth; the shark therefore benefits from the natural hygiene service provided and in return allows the small fish to feed and survive. It is in the interest of neither party that the powerful shark swallows its small service provider.

In this dissertation the natural science definition of symbiosis is modified in several ways to suit the business context. To demonstrate symbiosis it has been deemed appropriate that the SMEs must have noted, acted on and gained from the changes being made by the main manufacturer or assembler. In this way it can be argued that the parties (the main manufacturer and its subcontractors) are in a symbiotic relationship.

To test out the relevance and the academic viability of the symbiotic concept, it was felt that the study of a high-technology industry, for example aerospace, automotive, or electronics, would be appropriate. This is

because such industries typically experience major changes in their strategic environment. They were also industries in which a limited number of major firms acted as designers, financiers, assemblers and marketers while drawing on a large number of subcontractors for components. With this factor in mind, the aerospace industry was selected as it is perceived to be globally oriented, have transitory customers, utilizes high-technology, demands high quality assurance, uses an appreciable percentage of outsourcing, and consists of a limited number of major manufacturers that are easily identifiable.

The aerospace industry can be divided into civil aircraft, aero-engines, military aircraft, and aerospace segments. Because of this multifaceted operations it was deemed necessary to select one from the four segments. Civil aerospace was chosen as the appropriate industry segment for this study as it was deemed possessing more of the characteristics of continual change, identifiable, and user of component suppliers. The next step was to identify a major assembler within the British civil aerospace industry.

The major civil aerospace assembler in the U.K. is British Aerospace, Plc. (BAe); they were contacted about participating in this research. BAe responded favourably by recommending that the civil airline division located at Prestwick, Scotland, be utilised as the research focal point. BAe Prestwick (Prestwick) is a complete assembler of two aircraft models - the nineteen passenger Jetstream 31 and the twenty-nine passenger Jetstream 41. Because Prestwick is a complete assembler, in effect a small-scale major manufacturer, BAe often chooses them to be the test site for innovative ideas and manufacturing methods.

Prestwick routinely outsources about sixty percent of their components and subassemblies. This factor, and their smaller size,

increases the probability of changes at Prestwick being observed and responded to by their supplier network. In addition, the Jetstream model 41 was beginning production after the research was started, so multiple manufacturing, purchasing and quality assurance changes were being introduced as part of this new model introduction phase.

Extensive interviews were conducted with management and line personnel at Prestwick. These interviews established that significant changes were being undertaken at Prestwick concerning manufacturing methodology, quality assurance, purchasing practices, and management information systems within the previous three years. These responses to the changed strategic environment by Prestwick management were verified by the researcher's observations and third-party comments or observations (thus providing triangulation of facts by observation and independent verification).

A component supplier list was obtained from Prestwick from which a 'disproportionate stratified sample' was chosen. The research sample was limited to small and medium sized component suppliers (SMEs). Out of Prestwick's component supplier list, thirty-four firms were selected and later interviewed during the fieldwork phase of this research. The main issues discussed with the SMEs were whether they observed changes at Prestwick, were, and to what extent, the SMEs making consequential mirror-image or similar changes, were the SMEs influenced by Prestwick in making their own changes, and finally, did the SMEs perceive the changes made by both parties as being mutually beneficial and commensal?

The results established that there was a growing symbiotic relationship occurring between the major manufacturer and thirty-four of its component suppliers who were studied in this research. These symbiotic changes meet the definition of symbiosis, mutual beneficiality and

commensality as defined in this research. This case study therefore has justified the use of the symbiotic concept, modified for business purposes, as a useful tool for examining and analyzing the changing relationships between the major assembler and a sample of subcontractors in the civil aerospace industry.

1.2 Defining Symbiotic Changing Relationships

Major manufacturers and their component suppliers are changing certain key manufacturing, procurement and administrative systems in reaction to exo- and endogenous changes from their operating environment. The research objective of this dissertation is to explore whether symbiotic changing relationships exist between an aerospace major manufacturer and a sample of its small and medium-sized component and material suppliers, all of which are known to be making changes in their manufacturing, quality, procurement and administrative systems.[1] The search focuses from system changes to the changing relationships experienced by the participants as they react to various factors affecting their environments.

A symbiotic changing relationship is redefined, for purposes of this dissertation, as occurring when two entities are each undergoing specific changes in their manufacturing, purchasing or administrative support systems, and their business relationships are changing concurrently. This changing relationship often includes a commensal association between the two business entities. Further, it is likely that both entities receive mutual benefits from the changes undertaken. This definition is further extended to

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1. The natural science term of symbiosis, as defined later in this chapter, is modified to describe mutual beneficiality, commensal associations, and changing relationships from a business context. The changes that each of the participants are undergoing are explored for similarity and/or mirror-imaging of each other, which is also discussed further in this chapter.

include the concept of mutual changes, either similar or mirror-images of each other, by the two different sized entities involved.

Beneficiality and mutuality are arguably considered essential components of a changing symbiont relationship. The natural science definition of symbiosis stresses the importance of beneficial behaviour amongst the participants in a symbiont relationship. In addition, both terms strengthen the concept of a mutually changing relationship existing between firms that are undergoing symbiont changes.

The beneficial behaviour criteria supports the existence of mutuality between two or more parties in a relationship. The modified definition used herein divides mutuality into two aspects:

(1) mutual benefits received by each of the partners in the association; and

(2) mutual changes that are similar or mirror-image of each other between the two business entities.

The term mutualism as used in this dissertation is unmodified from Gotto's definition: "... to cover associations in which mutual advantage is apparent, but without the implication that the partner's are ultimately dependent on one another in the physiological sense." (Gotto, p. 15.) Mutualism can be confused with symbiosis, but it essentially differentiates the more flexible business relationship whereby one partner does not become physically dependent on the other partner in the relationship. Mutualism supports the concept of symbiotic change without weakening the definition. Mutualism adds the dimension that business partners are not necessarily dependent upon each other, but still react simultaneously to beneficial change.

The implication of symbiotic changing relationships to this dissertation includes the realisation that changes can exist simultaneously in both

entities, acknowledgment of influence over similar changes amongst the entities, actual implementation of similar or mirror-image changes, and existence of mutual beneficiality and commensal associations from the relationship.[2]

1.3 Specific Areas of Change Studied

This adapted natural science definition of symbiosis is focused on three specific areas of change during this research:

(1) Manufacturing methods and quality procedures, because these are relative to a high technology industry where change is normal and frequent.

(2) Purchasing and marketing methods and systems, because these systems are the antithesis of each other when viewed from a manufacturer's (purchasing) and a supplier's (marketing) perspective.

(3) Administrative information systems, because these should be directly interactive with manufacturing and purchasing systems. Examples of information systems include cost accounting methodology, electronic interface between shop floor and accounting data bases, vendor payment schemes and electronic purchasing or ordering systems.

This symbiotic search is necessary in today's global business environment because the arms-length competitive relationships of prior years are blurring or even disappearing. Large or small businesses can no longer afford to compete in isolation and operate independently of each other. W. Edwards Deming has advocated for decades that the adversarial

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2. Mirror-image changes are distinguished from similar changes because they are the reverse from one entity to the other. For example, if Prestwick is making a purchasing change to single-sourcing, do the affected component suppliers adapt their marketing procedures? One example of a marketing strategy change in reaction to single sourcing may be for the SMEs who were not awarded the single-source contract to seek sub-contracts with the successful single-source bidder.

arms-length competition between businesses must cease and a feeling of mutual trust be developed. The interactions between firms, industries, consumers and governments are increasing and require a more commensal and cooperative attitude amongst the participants. Businesses are having to cope with increased environmental pressures, changing government regulations and a rapidly increasing shift to global competition; all of which nurtures cooperation and beneficial relationships. This development of commensal relationships encourages an environment of symbiotic behaviour. This environmental change raises the issue of whether symbiotic change is a reaction to a new business environment, or is it a naturally occurring phenomenon. This research addresses this question of the root of symbiont behaviour.

2.0 RESEARCH OBJECTIVES

The search for symbiotic changing relationships queries four research objectives that possibly may exist between a major manufacturer (or assembler) and its component suppliers. These objectives acknowledge that changes are underway at the major manufacturer that meet the criteria for affecting symbiotic relationships between the entities:

(1) Research objective one:

Have the changes by a major assembler in manufacturing, quality assurance, purchasing, and administrative support systems been observed by a sample of its SME component suppliers?

(2) Research objective two

Have the SME component suppliers that observed designated changes at the major assembler made similar or mirror-image changes in their procedures and methodologies?

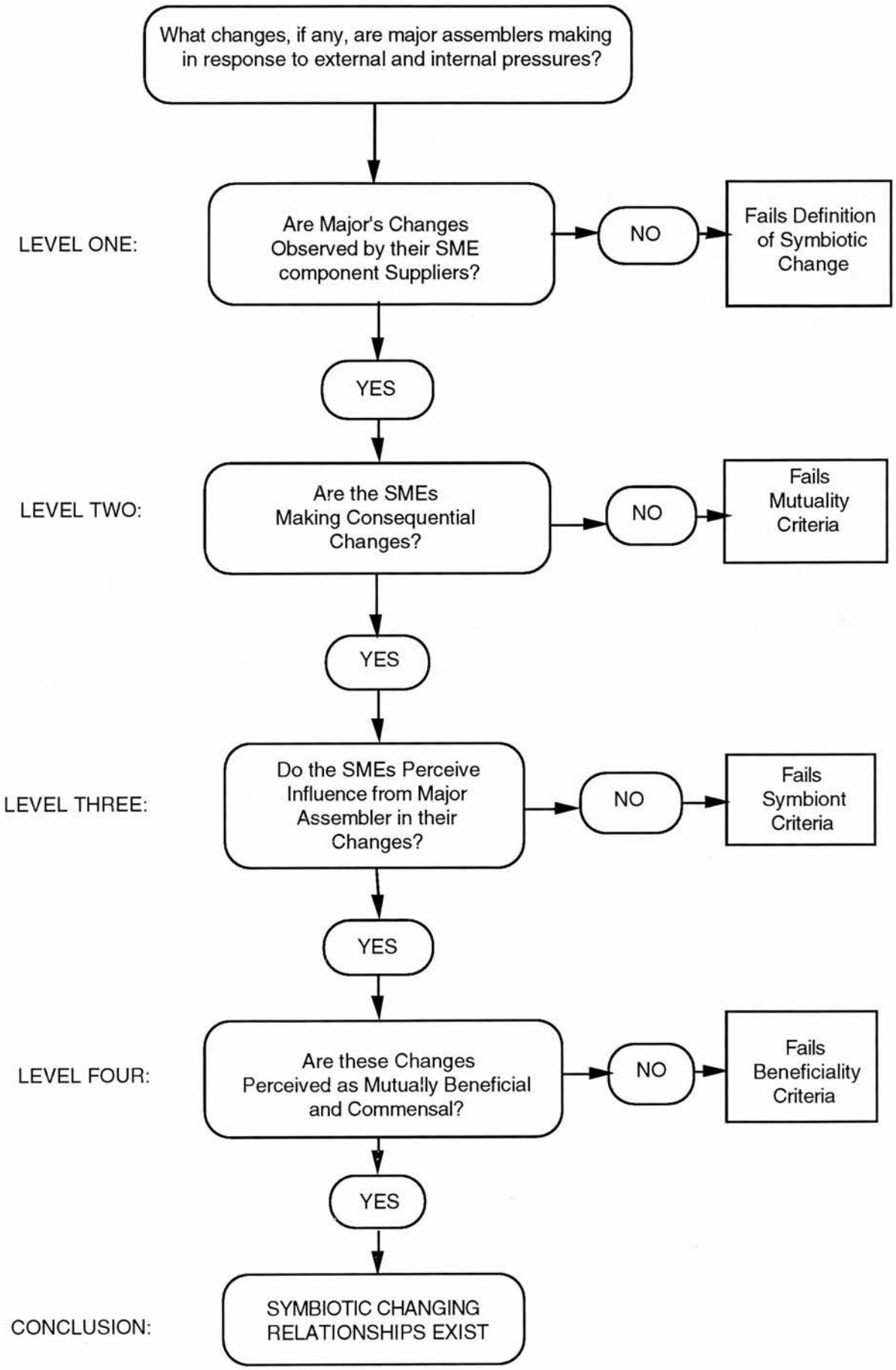
(3) Research objective three

Is there perceived influence from the major assembler upon the component suppliers concerning the decision to make similar or mirror-image changes in manufacturing, quality assurance, purchasing and management information systems procedures or methodologies?

(4) Research objective four

Are these changes made by the major assembler and a sample of its suppliers perceived as commensal and/or mutually beneficial?

Table One - Research Objectives



2.1 Discussion of Table One

The basic premise to symbiotic changing relationships is that major assemblers are making recent and significant changes in specified manufacturing areas. This premise is examined from the perspective that Prestwick is using the introduction of a new aircraft model, the Jetstream 41, to implement many of these changes. This research found changes are being undertaken in Prestwick's manufacturing methodology (production and quality assurance techniques), procurement procedures, and administrative support systems within the previous three years.

2.1.1 Recent JIT manufacturing changes occurring at Prestwick include:

(1) A flexible build programme where build-sets consist of ten aircraft instead of the previous thirty; modifications or change orders to each build-set are kept to a minimum.

(2) A cost reduction programme with more commonalty of parts, use of standard versus special design parts whenever possible, and/or decreases in the overall total number of parts.

(3) JIT delivery of component and assemblies clearing quarantine as needed for the projected build schedule. Delivery dates are 'backflushed' from the aircraft's scheduled delivery date to each particular segment of the applicable build programme.

(4) Increasing use of suppliers to include design and development of components and assemblies to meet Prestwick's specifications.

(5) The cellular manufacturing methods implemented at Prestwick are located at appropriate build stations along the assembly process. The attempt is to use an assembly work cell, with varied types of equipment and tools necessary for that particular task or series of tasks.

(Aircraft do not move down an assembly line; considerable work is done at each location, the aircraft is then moved to the next assembly station.) An open shelf (bin) parts system is utilised at the cell to place parts or assemblies needed for that build, readily accessible to production personnel; a modification of the Toyota kanban system. (Above information was obtained from interviews with Prestwick's personnel, and BAe's public information policy brochure.)

2.1.2 Levels of inquiry

The four levels of inquiry used in this dissertation are not dependent upon each other to establish conclusively the existence of symbiotic change. However, the existence of the criteria strengthens the argument for symbiotic changing relationships existing between the two different sized entities.

Level One of Table One

Level One queries whether the previously defined changes at a major assembler have been observed by the component suppliers selected for interviews. Ninety-four percent of the interviewees have observed one or more previously specified changes at Prestwick.

Level Two of Table One

Level Two queries the component suppliers to establish if they are making similar changes within their organization. Seventy-six percent of the respondents are making mirror-image changes similar to the changes at Prestwick.

Level Three of Table One

Level Three seeks management's perceptions of the degree of influence from the major assembler concerning their decision to implement changes in their SME. Twenty-six of the respondents felt that Prestwick had some degree of influence over their decision to make changes previously defined.

Level Four of Table One

Level Four activities are the perceptions of commensalism and mutual beneficiality of the changes, at both Prestwick and SME levels of activity. The SMEs rated three of the six areas queried as beneficial, with the remaining three areas rated as slightly unfavourable. All six areas were recognized as commensal in their commonality of build programme.

Arguably, the areas lacking beneficiality are not interpreted as indicative of the non-existence of a symbiont relationship. Mutual beneficiality may be interpreted as a management state-of-mind at a certain point. For example, several managers did not rate beneficially the change to smaller production lot sizes. They believed that once the production equipment was set up it is more economical to make large-volume production runs and hold any excess in inventory for later demand. This management attitude may be an indicator of lack of understanding of the benefits of JIT production methods, not of a lack of understanding the benefits of symbiont change.

2.2 Selection of Specific Areas to Query

Three operating areas of potential symbiotic change were identified for this dissertation and queried during the interview process:

(1) Manufacturing methodologies - include production methods and quality assurance programmes.

The aerospace industry is generally considered a high-technology industry utilising the latest developments in materials, innovative design, and advanced electronics. The industry is responsive to customer demands and changing needs. The industry is willing to incorporate new techniques into its manufacturing methods and procedures. Extremely high levels of quality control and documented assurance are mandated by customer

specifications and strict government regulations. Because of these parameters stated above, it is deemed likely that change could be observed at both the major manufacturer and the SME component supplier level within the civil aerospace industry.

This research established that Prestwick and the SMEs are making manufacturing changes toward just-in-time manufacturing methodology, cellular manufacturing techniques, and total quality assurance programmes implementation.

(2) Procurement procedures - include purchasing and marketing interface changes.

Purchasing procedure changes were selected for inquiry at the major manufacturer and SME levels, and marketing changes were selected for inquiry at the SME level. The major manufacturer has been making significant changes in its purchasing methods and sourcing requirements, as explained in chapter five. The changes include single-sourcing for a larger percentage of the components, smaller build-sets, longer payment terms, supplier participation in design and launch costs, and more frequent delivery of smaller lots.

These changes in Prestwick's purchasing procedures were queried at the SME level to determine whether they had made mirror-image marketing changes, and were they aware of the Prestwick changes. For example, if the SMEs were making marketing changes, they were queried to determine if this was in response to the purchasing changes at Prestwick. The SMEs perception of Prestwick's influence upon their marketing changes was also queried.

In addition, the component suppliers were queried as to which changes they were implementing, or had already implemented within the past three years, concerning their purchasing procedures, supplier

relationships, and the extent of influence, if any, Prestwick had upon these changes.

The purpose of this set of questions was to determine if the SMEs were making similar and/or mirror-image changes as those made by Prestwick. A second purpose was to determine what degree of influence upon the SMEs decision Prestwick exercised, as perceived by the SMEs management.

(3) Administrative Changes

The third area queried included administrative procedural changes to support the informational needs for the operational changes mentioned above.

The Prestwick administrative changes observed by the SMEs included timing differences in making payment for invoices, planning for paperless ordering procedures, budgeting and cash-flow analysis, and communications procedures and techniques.

Another cash-flow management change by Prestwick is to induce major component suppliers to participate in the up-front research and development costs, either through direct financial contributions, or by assuming responsibility for research and design of their respective components. This is an example of matching buyers' purchasing needs with the specific R & D capabilities of the supplier and becoming part of the selection process. (Porter, 1980).

The SMEs were queried as to what extent they changed or adapted their internal accounting and managerial control and information systems in response to the changed production, quality or purchasing procedures. The SMEs have made changes in paperwork handling procedures, internal and external communication procedures, identification of administrative procedures needing improvement, and cash-flow projections and analysis.

One example of administrative information change is computer linkage between the shop floor and the administrative office. This linkage was being considered by several of the respondents, but only one had begun implementing this procedure and estimated that there would be several years before completion. Several other SMEs had budgeted computer linkages into their equipment acquisition planning during the next three years.

3.0 STATEMENT OF RESEARCH PROBLEMS

3.1 The research problems addressed by this research are at least threefold:

(1) The first problem to be addressed is that the aerospace industry is constantly undergoing change. These changes include procedural (e.g., just-in-time and cellular manufacturing) and technological (e.g., quality measurement, design, materials and electronic innovations). These changes are often reflected in new methods of manufacturing, quality assurance programmes, materials utilised or technology employed, or in purchasing policies and procedures.

(2) The second problem the aerospace industry faces, in a manner similar to the automotive industry, is that it uses a large proportion of component suppliers compared to in-house manufacturing. Boeing, for example, typically buys more than sixty percent of its parts and components from outside suppliers. Prestwick is typical in this buy-in pattern, with nearly sixty percent of its components normally purchased from outside suppliers. This high usage of subcontractors creates a large supplier base that is diverse and more difficult to subjectively measure or comprehend.

(3) The third problem, common to many industries, is the lack of adequate information about changes, and which of those changes are common between the major manufacturer and its suppliers. A scholarly research on symbiotic change between two dissimilar-sized entities, specifically within the aerospace industry, was not found in the literature search. Furthermore, a symbiotic changing relationship between a major manufacturer and its component suppliers operating in several different industries besides aerospace has not been significantly discussed in the literature as of the research date.

3.2 Conclusions about the research problems

Because of the extent of interaction between the major manufacturer and its component suppliers, and because of the importance of change in procedures and methodology within the aerospace industry, symbiotic change is worthy of a scholarly study. The pertinent parameters assigned to this study include:

(1) The need to understand more fully the myriad relationships existing between a major manufacturer and its component suppliers, each of which are undergoing observable changes. This interaction between the dissimilar sized entities is complex and subject to variations because of exogenous and endogenous influences upon the industry. A scholarly study is needed to determine, document, and more fully explain the interactive processes in existence within the aerospace industry.

(2) The need to study the amount of change in the aerospace industry. Industry changes, amongst others, include:

(a) new materials, e.g., composite carbon fibres in place of aluminium or titanium;

(b) new technology, e.g., fly-by-wire instead of hydraulic controls;

(c) manufacturing changes and methods, e.g., cellular manufacturing techniques, just-in-time production and delivery methods;

(d) new entrants, changing roles of existing competitors, and threats of alternative forms of travel - all of which affect the aerospace industry.

(3) The need to study the interaction of the aerospace industry with other industries.

The aerospace industry utilises a spectrum of materials, parts and component suppliers from a myriad of other industries. For example, among the thirty-four component suppliers interviewed as part of this research, few supplied aerospace companies exclusively on a long-term basis. Many of the managers of companies interviewed preferred operating simultaneously within two or more industries besides aerospace. Other industries that they operated within include automotive, surface coating, communication, electronic, forging, petrochemical, plastic, and engineering, amongst others.

4.0 ORIGINAL CONTRIBUTION TO KNOWLEDGE

4.1 Gap in the Present Level of Knowledge

In the literature search conducted for this dissertation, the researcher did not find a scholarly research thesis or journal article specifically on symbiotic changing relationships between dissimilar sized entities. This dissertation addresses this issue. This gap in the current literature is deemed important to the overall understanding of symbiotic change

between two dissimilar sized entities, and is specifically researched using the aerospace industry.

Second, the complexity of symbiont relationships between two dissimilar-sized organisations operating within the aerospace industry has not been extensively researched. This gap in understanding the essence of power between a large manufacturer and its SME component suppliers has not been addressed previously. This issue is specifically addressed in this dissertation. The changing power relationships between entities, and their effect upon symbiotic change, has wide-ranging implications upon manufacturing, quality assurance, purchasing/marketing, and management information systems from both short and long-range planning perspectives by both entities concerned.

Third, the complex relationships between component supplier firms operationalising amongst aerospace, automotive, electronic and other industries need more exploration and description than can be found in the present level of knowledge. This issue is specifically addressed in this dissertation. The interchange of manufacturing techniques, specialty materials, purchasing procedures and direct competition for use of the major manufacturers from other industries also may affect the balance of power between Prestwick and its component suppliers.

4.2 Contribution to knowledge

This dissertation makes original contributions to knowledge concerning the following:

(1) This research contributes to knowledge about symbiotic change between two dissimilar-sized entities. This knowledge encompasses the concepts of mutuality of change and the beneficiality of change between the commensal entities.

(a) Different sized entities are chosen for this dissertation to determine whether influence can be detected. Influence may be more difficult to detect if changes between two equally-sized entities were studied.

(b) Mutuality of change is deemed necessary because to detect influence and symbiosis it is necessary to identify similar or mirror-image changes occurring nearly simultaneously within both entities.

(c) Beneficiality of change is deemed important because it is an enhancement or inducement to facilitate change; therefore it is considered an advantage to identifying symbiosis. Commensal relationships are arguably assumed to be an indicator of at least temporary beneficiality.

(2) This research contributes to understanding the symbiont relationships existing within the aerospace industry. As explained in further chapters, the aerospace industry is a complex operating environment, with global sourcing and cross-industry utilisation of methodologies, components and materials. This description enhances the understanding of symbiosis between changing business organisations, as well as the evolving relationships between dissimilar-sized entities. The symbiont relationships potentially existing between the entities include:

(a) major manufacturer to SME component supplier,

(b) major manufacturer to the commercial airline customers, and

(c) interactions with other industries.

(3) Third, this research contributes to the present state of knowledge of the interactive complexities of a commensal relationship between an SME and a much larger firm. This relationship encompasses

the establishment of change, establishment of symbiosis and the establishment of mutual beneficiality. The interaction must also address the purchasing - marketing interface between the two entities, dependence building, economic considerations, sharing and transferring of technology, and evolving relationships from new methods and techniques. For example, adoption of just-in-time manufacturing methods has an effect upon:

(a) purchasing methodology - single-sourcing;

(b) delivery methods - smaller, more frequent deliveries;

(c) build-lot sizes, and cellular manufacturing techniques;

(d) computerisation of the assembly line;

(e) downstream influence of buying-in of supplies and raw materials;

(f) quality assurance;

(g) changing roles for managers and development of management skills and techniques; and

(h) employee empowerment.

5.0 SUMMARY OF INDIVIDUAL CHAPTERS

5.1 Chapter Two - Review of the Current Literature

Primary question - what literature is pertinent to the subjects covered in this dissertation?

A thorough search of the current literature was necessary to understand the primary research objective of identifying the existence, or non-existence, of symbiotic change between a major manufacturer and its SME component suppliers. The literature search had to include the

perspectives and influences acting upon the SME component supplier, as well as the international operational factors imposed on the major airframe assembler and civil aerospace industry.

The literature search was strongly influenced by four operational environments: global, government, business and strategic.

Chapter two includes a general description of symbiosis, methodology of change in specific operating environments, global context of the aerospace industry, governmental influences upon the industry and strategic drivers affecting civil aerospace. Special relationships are searched concerning large and small firm interactions, purchasing-marketing interface, joint ventures and customer interactions.

5.2 Chapter Three - Research Methodology Used

Primary question - what research methodologies are appropriate for this dissertation?

This chapter explains the selected research design and implementation methodology, as well as the analytical techniques used in this dissertation.

The three limiting factors affecting methodology and implementation were identified and incorporated into the research design and methodology:

- lack of a previous comparative study,
- participants' spectrum of operations,
- diversity of the aerospace industry.

Because of these limiting factors, and because of research objectives, the combination of a single case study for Prestwick and multiple case studies of the SMEs were considered more appropriate for this research project.

The final part of the chapter explains the data collection procedures and describes the selection of the statistical analytical techniques to be used in analysing the data.

5.3 Chapter Four - The Civil Aerospace Industry

Primary question - what is the current operating environment of the civil aerospace industry?

The purpose of this chapter is to review the various factors influencing the aerospace industry and its operational levels applicable to both the major manufacturer and the smaller component suppliers. This overview of the industry includes general characteristics, the Western players and Japan, the Eastern European players, and the other, newly industrialised players.

The second part of this chapter describes the evolutionary highlights of aviation, and then gives a summary of American and British experiences. Other major sections include current markets for commercial aircraft, component suppliers, location aspects, technology and research, and influence of government upon the industry.

5.4 Chapter Five - The Major Manufacturer

Primary question - what is the current operating environment of BAe Prestwick?

The purposes of this chapter are:

(1) To describe BAe, Plc., in general; and the Prestwick Civil Airlines division in more detail.

(2) To query what changes had occurred during the previous three years and which were in-process as of the interview date. The specific changes being made at the Airlines Division, Prestwick are

described as well as the composition of their buy-in of components, parts and materials.

(3) To observe which exogenous and endogenous management drivers are involved at Prestwick.

5.5 Chapter Six - Prestwick's SME Component Suppliers

Primary question - what is the present state of the SME component suppliers to Prestwick?

The purpose of the chapter is to summarise the present state of thirty-four small and medium-sized component suppliers as found during this research, using the narrative approach of exploratory research. This section reviews the interviewees' position and experience, opinions, perceptions, and background information about the company.

The interviews established that changes were being made in the three previously-discussed areas at the SME level; that Prestwick influences the decision-making of the SMEs; and that there is symbiosis between the changes of the two dissimilar sized entities.

5.6 Chapter Seven - Research Conclusions, Limitations and Recommendations

This chapter summarizes the research information and data gathered during the fieldwork, analyzes this information, and then draws appropriate conclusions. In addition, limitations of the research are recognized and recommendations are made for future empirical studies.

This chapter describes and analyzes four separate aspects of the symbiont relationship between the major manufacturer and its component suppliers:

(1) SME awareness of Prestwick changes,

(2) changes by the SMEs,

(3) Prestwick influence upon SME changes,

(4) determination of symbiont relationships between Prestwick and its component suppliers.

In addition, correlation analysis is made between Prestwick influences and SME changes, changes within Prestwick, and finally, the changes within the SMEs.

6.0 CHAPTER SUMMARY

This chapter introduces the concept that the competitive and strategic environments of businesses are changing because of various endo- and exogenous factors. This changing environment is causing businesses to make changes in their manufacturing, quality assurance, procurement and administrative support systems. These changes are emulated by the component and materials supplier network that commensally associate with the major manufacturers. As both entities make changes, the phenomenon of whether the relationships between them must also change is studied. A variation of how to observe and measure these changing relationships was selected - the natural science event of symbiosis.

This research was undertaken to discover the existence or non-existence of symbiotic changing relationships between a major manufacturer and its component suppliers. The research aims to describe the interactive relationships and limitations amongst the participants.

This chapter defines the problems to be solved by this research dissertation, the research objectives, the original contribution to knowledge that this dissertation makes, and a brief description of chapters two through seven. The literature supporting these areas is discussed in chapter two, following.

CHAPTER TWO INDEX - **REVIEW OF THE CURRENT LITERATURE**

CHAPTER TWO - **REVIEW OF THE CURRENT LITERATURE**

1.0 INTRODUCTION

As discussed in chapter one, Western manufacturers are experiencing significant threats from increasing competition, new entrants, alternative products, bargaining power of suppliers and customers, and shareholder demands. Reacting to these challenges, large and small firms are striving to regain their manufacturing preeminence by changing their operating methods and business strategies. The increasing implementation of change by Western manufacturers to meet these threats and opportunities are affecting the traditional business relationships between major manufacturers and their myriad subcontractors and suppliers.

The nature of these new relationships raise in turn the question of how the subcontractors react, if at all, to the requirements of their major manufacturing customers. There is academic and anecdotal evidence suggesting that the changing relationships are leading to greater mutual dependency between the prime manufacturer and their suppliers. This changing dependency may also be indicative of a commensal relationship between the entities involved. (Thomas and Bennis, 1972; Stoner and Freeman, 1992; Bolwijn and Kumpe, 1990; Porter, 1986; Lubben, 1988; Brown and Mitchell, 1991; McMillan, 1990; Ackoff et. al., 1984; and James, 1990.)

The forces effecting changes in business methods and relationships are intensifying as the the manufacturing base is approaching global proportions. Newly industrialised countries are increasingly becoming real threats to the advanced industrialised countries. The pace of change quickens as product life becomes shorter due to innovations and

obsolescence. Government interactions and interventions are more pronounced as more countries enter the industrial base. All of these factors establish the need for changing relationships and methodologies between small and large companies.

The traditional approaches examining these changing relationships queries classic economic theories of supply and demand, or the more modern concepts as transactional cost analysis theory. These theories do not satisfactorily explain the simultaneous changes being implemented by major manufacturers and their suppliers, the pressures exerted upon the participants, and the change in the relationships between these entities. Because of this void, the natural science phenomenon of symbiosis is tested as a more satisfactory explanation of mutual changes and increasing dependency between the two participants. A conclusion is reached to address these relationship issues in an alternative manner, drawing on the phenomenon of symbiosis to describe the changing relationships between the business partners.

The focus of this literature search is therefore on symbiosis, economic theories, forces acting upon industry, procedural changes, and changing relationships. This review is then summarized into the perspectives of modern industry as related to the civil aerospace industry, chapter four, and the major assembler and SME component suppliers, chapters five and six.

2.0 SYMBIOSIS

2.1 Defining Symbiosis

Symbiosis is examined from the natural science perspective and redefined, or modified, to meet the needs and terminology from the business perspective.

2.1.1 Natural science definition

The term symbiosis was first used by De Bary in 1879, literally meaning 'living together'. "...But even the writers of antiquity were aware of certain curious associations involving at the very least toleration, and, at most, clear mutual benefit. Thus Herodotus describes a relationship between the crocodile and a bird - now provisionally identified as the Egyptian plover - which enters the reptile's jaws with impunity in order to feed on the ever-present leeches." (Gotto, 1969, p. 13.)

The natural science definition of symbiosis in its simplest form is the living together of two dissimilar organisms; normally this association is mutually beneficial. Gotto defines symbiosis as "...a state of affairs in which organisms live together for mutual benefit in such close relationship that each has lost at least some degree of physiological independence."[3]

To understand fully symbiosis, the reader must also understand the terms mutualism and commensalism. Gotto defines mutualism as any association involving reciprocal benefits, but without the ultimate dependency upon one another in the physiological sense. Gotto also defines commensalism as 'at the table together', in the classical sense of both organisms sharing the same source of food, with no harm occurring to either. Gotto states that the actual process of providing the food source is usually carried out by one of the organisms, creating a one-sided benefactor from the relationship.

As explained in footnote one, the natural science definition of symbiosis is freely modified for usage in this research. The essential elements of symbiosis are maintained: two or more dissimilar sized entities, mutual beneficiality and commensal association. To these essential

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3. Gotto, 1969, p.16.

symbiont relationship descriptors, the exogenous environmental factor of change is added: determining the existence of change, its observability, and the extent of influence of change upon or by others. The existence of change is added to the modified symbiosis definition as a catalyst for identifying any symbiont relationship existing between markedly dissimilar sized entities, and as an indicator of the existence of symbiosis. This research focuses on changes at Prestwick and thirty-four of its small and medium-sized component suppliers; therefore the identification of mirror-image changes occurring during a similar time period are arguably defined as an additional indicator of symbiosis.

2.1.2 Business definition

A symbiotic changing relationship is defined, for purposes of this dissertation, as occurring when two entities are each undergoing specific changes in their manufacturing, purchasing or administrative support systems, and they are concurrently experiencing changing business relationships. This changing relationship often includes a commensal association between the two business entities, whereby both parties participate in the benefits and responsibilities of the business arrangement, but only one party obtains the sale. Further, it is likely that both entities receive mutual benefits from the changes undertaken, which is one of the implicit assumptions for making the change.

The business definition is further extended to include the concept of mutual changes, either similar or mirror-images of each other, by the two different sized entities involved. In essence, the entities are changing in a similar manner or towards a common goal; e.g., a change towards cellular manufacturing techniques by both the major assembler and its component suppliers.

The key element in this definition is the concept that the relationships between both entities are changing because of the new methodologies or procedures require or encourage new relationships or interactions between the entities. For example, JIT purchasing techniques require that the buyer and seller work closely together to prevent uninterrupted flow of materials and defect free quality; this closeness encourages better communications and more of a partnership relationship than the former adversarial buying techniques which frequently pitted buyers against their suppliers. These relationships will be explored later in this chapter.

Mutually beneficial is construed to mean that each of the participants benefit commercially and perhaps technically from the product build, and are driven by varied endo- and exogenous factors to continue the relationships between the major assembler, parts supplier, and customer. Further, the term mutually beneficial is extended to include the benefits derived from symbiotic changing procedures involving possibly manufacturing, quality, procurement and administrative systems by both participants.

Mutuality is used twice in this modified definition. First, mutuality of benefits is stressed. This is intended to imply that both of the organisations receive benefits from the changes being undertaken. Gotto states that the word itself stresses reciprocal benefits between the two partners involved, but more importantly, that both parties are benefitting from the relationship. Gotto's implication is important because once it is established that there is a changing relationship, thence it must be determined that both parties are benefitting from the changes in their relationships. (Mutual beneficiality.)

The second use of mutuality concerns the mirror-image changes which both organisations are undertaking. Gotto warns mutuality can often be mistaken for a synonym of symbiosis, which is not intended in this dissertation. Mutualism is intended to mean reciprocal benefits received

without implying dependency between the business partners, therefore the term commensal association is added to the definition to imply changing relationships and increasing dependency between the participants. The term 'increasing dependency' is important to establish changing symbiotic relationships between the participants in a changing environment.

2.2 Commensalism

Gotto's description of commensalism literally means sharing the table together with the 'meal' provided by one of the parties, with no harm to either partner involved. Commensalism, as used herein, means all parties to the contractual arrangement sharing the common goal of building a product for their customer, even though one of the partners obtained the original sale.

The literal meaning of commensalism is modified herein to mean two business entities working on the same project and achieving the same goals with no disadvantage to the other. The contractor - subcontractor relationship could be described as a commensal relationship. Both entities share the common economic and physical goal of building an aircraft for a specific customer, even though one entity is responsible for obtaining the sale.

The primary difference between the natural definition and this modified version is that the natural definition assumes one-sided advantages between the two organisms, with one commensal partner receiving unearned food. The business relationships studied in this dissertation assume that goal sharing is mutually beneficial, and that both parties contribute (commensally) towards the ultimate objective. (E.g., a commensal objective could be the shared goal of building and delivering a completed aircraft to an airline customer.)

Commensal relationships, as used in this dissertation, are not restrictive and allow for increasing dependency between the parties involved in the changes.

2.3 Changing business relationships

Changing relationships are introduced into the definition to recognize that to compete and survive in the modern business world the older manufacturing methods are no longer practical. Many exo- and endogenous factors, ranging from foreign competitors, new entrants, alternate products, JIT manufacturing techniques, and new technologies mandate changes by the manufacturing participants in the build hierarchy. These same factors also imply that the relationships between the purchaser/marketeer must change in reaction to the same external and internal forces acting upon the participants.

(The above subjects are discussed by Heinritz and Farrell, 1981; Segal, 1989; Dion et. al., 1990; Ashton, 1986; Evans and MacKenzie, 1988; Giunipero, 1990; O'Neal, 1989; and Pearson and Gritzmacher, 1990.)

In a like manner, the administrative support systems must also change to meet the informational needs of the new procedures. The older style information systems that were often criticized for providing 'to much, to late' are being replaced with 'live' information systems and reports that provide more useable information, and faster, to management and line personnel. (Various Aviation Week and Standard and Poor's articles; Brimson, 1988; Cocker, 1989; Grinyer et. al., 1990; Beaujon and Singhal, 1990; Borden, 1990; Innes and Mitchell, 1989; Johnson and Kaplan, 1987; Maskell, 1986; Murphy and Braund, 1990; and Dent, 1990.)

Changing relationships are discussed further in a later section of this chapter.

3.0 ECONOMIC THEORIES

3.1 General discussion

The relevancy to modern industry of neoclassical economic theories popularised by Keynes, Galbraith and others, is questioned by this researcher. These trade theories purport that materials or products move relatively freely between countries whilst the basic factors of production do not. In many modern industries the basic factors of production move relatively freely between countries. This has been illustrated with the relocation of steel producing first to Japan and then to Korea and Taiwan, ship-building from Britain to the Pac-rim countries, electronics from Western countries to Pac-rim countries and other examples. This literature review assumes that the reader has had multiple exposures to the classic economic theories, and therefore concentrates on other theories seeking explanations for changing relationships.

The relevancy of another popular theory, the Heckscher-Ohlin 'factor endowments theory of relative advantage' determining the country's specialisation of international trade is not considered adequate to explain changing business relationships. This theory explains international trade through use of special factors limiting entry. Because of the substantial involvement of governments within and upon industry, there does not appear to be a significant specialisation of factors limiting entry into industry if the 'price' is willing to be paid. More simply stated, a country's favourable endowment of specific factors (e.g., mineral abundance, location, previously trained workforce) is not an entrance requirement; the entry is dependent upon governmental considerations, cost, and advanced technology.

Professor Robinson places in perspective the relevancy to management decisions of these various trade theories... "Management is

not interested in average efficiency of a country, but more concerned with their firm's relative position and efficiency, movement of products, capital equipment, labor etc.".[4] His perspective is considered relevant concerning the international viewpoint of the SME component suppliers interviewed, where the managers are more concerned about the survival of their firm than national interests. Robinson and other authors who address the 'greening of industry' also argue that environmental influences may be more powerful in certain circumstances than factors of endowment or other classic trade theories.

3.2 Transaction costs

"Transaction cost economics is an interdisciplinary undertaking that joins economics with aspects of organizational theory and overlaps extensively with contract law. It is the modern counterpart of institutional economics and relies heavily on comparative analysis."[5]

Williamson begins his explanation of transaction costs using the triad of "...(1) bounded rationality, (2) opportunism, and (3) asset specificity." (p. 177). In essence, he interprets this as the cost of running the entire economic system, not just product costs. The first two factors are considered constraints that inhibit transaction costs and often must be overcome via the specific use of assets. The presence of both bounded rationality and opportunism is considered by Reekie to increase transaction costs for the firm because of their impediment to choice. In transaction cost analyses, assets become more specific as transactions become more defined or specific to the firm.

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4. Richard Robinson, 'Internationalization of Business: An Introduction', The Dryden Press, New York, 1984, Ch. 1.
5. Oliver E. Williamson, 'Economic Organization', (New York: New York University Press, 1986) p. 124.

(1) Bounded rationality

Reekie believes that firms operate under a limited information or knowledge constraint. He, and Williamson, make separate arguments that information available to management for decision making is incomplete, costly to obtain and benefits often do not justify cost. Given these factors, then rational decision making, as compared to intuitive decision making, is often limited to the amount of information obtainable under routine business conditions. Because of the presence of bounded rationality (limited knowledge or information), opportunism may become prevalent in contracting between two parties. Bounded rationality could be argued as a factor that increases symbiotic behaviour amongst firms, as they share technology and information because of limited information available. In other words, the need for additional information may increase the need for both parties to cooperate.

(2) Opportunism

Ricketts terms opportunism as the problem of knowing if the parties to the contract are completely fulfilling their obligations. Williamson and Reekie consider it more of a tendency amongst participants in the contractual arrangement to withhold or even conceal information, or to attempt other self-seeking advantages during the contracting (transaction) process. If one party can gain advantage over another as part of the transaction, then opportunism exists in the contractual process. Reekie terms opportunism as 'self seeking with guile' (p. 130.), and classifies it either as adverse selection or a moral hazard. Both authors consider opportunism as a recurring part of transaction analysis.

(3) Asset specificity

The third part of the transaction cost triad is asset specificity. Williamson contends that the production cost advantages of markets

decrease, and the governance costs of markets increase, as assets become progressively more specific. He believes that as asset use becomes more specialized and less transferrable to other users, firms realize economies of scale through operating the asset as compared to the use of outside vendors. Both Williamson and Reekie state that as contracting between parties increases and higher levels of trust are reached, fewer assets need to be deployed to justify future relationships. This is one example of why a new contractor has difficulty displacing existing parties, because a new participant could increase the opportunistic risk, or there is less information about them as compared to the existing relationship.

Williamson classifies asset specificity into three categories:

(i) site specificity - where successive stations are located in close proximity to each other to reduce buffer inventories and transportation costs;

(ii) physical asset specificity - special techniques, tooling or dies are necessary in the process;

(iii) human asset specificity - advantages of the learning curve and practical hands-on applications.

Williamson believes these three categories are critical factors because once the contract has been arranged and the assets specified, the buyer and seller are "... effectively operating in a bi-lateral (or at least quasi-lateral) exchange relation for a considerable period thereafter. In as much as the value of highly-specific capital in other uses is, by definition, much smaller than the specialized use for which it is intended, the supplier is effectively 'locked-into' the transaction to a significant degree." (Ibid, p. 142).

Williamson concludes his understanding of transaction costs differing from neo-classical economics, which treats as irrelevant the structure of the

firm, and the public policy theories which he envisages as unwanted intrusions into market processes.

> "The transaction-cost approach differs from both. Unlike neoclassical analysis, internal organization is specifically held to be important. Unlike the inhospitality tradition, structural differences are assumed to arise primarily in order to promote economy in transaction costs. The assignment of transactions between firms and markets and the economic ramifications of internal structure both come under scrutiny in these terms. The application of these ideas to the study of transactions in general and of the modern corporation in particular requires that (1) the transaction be made the principal unit of analysis; (2) an elementary appreciation for 'human nature as we know it' supplant the fiction of economic man; (3) transactions be dimensionalized; (4) rudimentary principles of market and hierarchical organization be recognized; and, (5) a guiding principle of comparative institutional study be the hypothesis that transactions are assigned to and organized within governance structures in a discriminating (transaction-cost economizing) way."[6]

Transaction cost analyses is useful in setting the stage for symbiont relationships and is referred to throughout this dissertation. The understanding of the complexity of change and interaction between firms is made easier by use of this method of economic analysis of the firm, and its relationship to transactions within the micro-economic system of transactions experienced by modern industry. However, transaction cost analysis fails to explore the mutuality and commensality of changes, and thus does not adequately describe symbiotic changing relationships. Moreover, it does not address directly the subject of changing relationships, therefor another explanation must be sought to explore these subjects. This reasoning supports the decision to turn to the natural science phenomenon of

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9. Ibid. p. 163.

symbiosis and relating it to changing relationships between a major assembler and its component suppliers.

4.0 FORCES ACTING UPON WESTERN INDUSTRY

4.1 Changing Philosophies

Western manufacturers are having to change their basic operating philosophy to meet the threats and opportunities mentioned in the introduction to this chapter. Two of the more significant changes in attitude are 'Japanization' of Western businesses, and increasing dependencies.

4.1.1 Japanization of Western Business

The phenomenon of Western businesses adopting practices and procedures of Japanese businesses has been termed 'Japanization'. The importance of the broad social, economic and political environments often termed Japanization are based on high-dependency relationships.

Oliver and Wilkinson discuss this adaptation by British industry at length in their book, as well as policy implications and relations. The authors stress the importance of achieving a 'good fit' of the Japanese practices to Western businesses, and not expecting these adapted practices to be a package for automatic success. In summary, the authors feel that the Japanization of British industry is a response to the problems encountered in international competition.

The just-in-time manufacturing techniques, statistical controls, total quality management and other practices perfected by the Japanese were learned from Deming, Juran and Crosby, British and American Professors who found believers in post-war Japan. For example, the British Spitfire combat fighter production efficiently utilised just-in-time techniques and met the Air Command's need for replacement aircraft during the Battle of Britain.

One Japanization practice, the cellular work concept, efficiently utilised by Toyota, originated in the Soviet Union during the 1950's. The Soviets started grouping machines by product family rather than machine function, which enabled them to specialize their tooling and simplify their production flows, thus mitigating the effects of capital equipment shortages. To maximise the effectiveness of cellular manufacturing, a flexible workforce is required, which necessitates the development of partnership feelings between management and line personnel. (Oliver and Wilkinson).

Heinritz and Farrell (1981) believe that long-range shortages of materials, power of the oil cartels and the effects of greening policies made companies rethink their shift away from long-term partnership arrangements with their suppliers as discussed by Bluestone et. al., (1981), and change once again toward non-adversarial policies. The authors discuss the new responsibilities purchasing assumes during the shortage years including new product development and long-range corporate planning functions related to materials acquisition and usage. As part of the long-range planning function, closer ties with suppliers becomes a must.

4.1.2 Physiological dependency factor

Part of the definition of symbiosis refers to the fact that symbiotic organisms lose part of their physiological independence because of their close relationship. (Gotto, 1969) This natural world phenomenon occurs in the business world also. Oliver and Wilkinson (1988) discuss a theory of dependency relations as a result of modernisation of British Industry. Their theory is that as companies begin achieving JIT production, procurement and delivery methodologies, there is a dramatic increase (authors' words) in the dependency between the various agencies involved. They develop their argument that power resides implicitly in the other's dependency theory. Oliver et. al. conclude that heterogeneity of goals and resource scarcity

provide the motivation to exert power and influence over partners by the firm achieving power. The specificity of asset portion of transaction cost analysis supports this contention also, as one firm becomes dependent upon the other to possess those assets and therefore not need them within their own firm.

Oliver and Wilkinson discuss two further aspects: "First, it will be clear by now that the characteristics sought of the organization's constituents (particularly suppliers and employees, but in theory potentially customers, governments, and others) will differ according to the type of production system. Second, wider social, political and economic conditions will have a bearing on the state of dependency relations and their outcome." (Ibid, p. 37).

Their concepts could be termed physiological dependency as firms move toward mutuality and eventually symbiosis. This movement sets the operating stage for adoption of foreign business practices by Western firms, which is termed Japanization.

4.2 Globalization Implications

Western industry is facing international competitive threats and business opportunities truly on a global scale. Components and assembly are commonly sourced half-way around the world in the electronic, automotive, aerospace, apparel and other industries, with final assembly performed in the host country. One of the disadvantages of this global sourcing is that technology is then transferred to the foreign country, and they may eventually emerge as a competitor.

4.2.1 Global competition

Western industries exogenous competitive factors are increasing as new firms emerge throughout the industrialized world and from third world

countries. For example, competition is arising from China, Peru, and other countries not considered a competitive threat a decade ago. (Young, Hood & Hamill, 1988).

Elwood Buffa (1984) recognised that the decline in Western productivity was due to poor management practices in Britain and America. He believes that these countries turned away from good management practices after WWII and started emphasizing marketing and mergers instead of manufacturing excellence. He advocates establishment of a cultural change that incorporates quality, price competitiveness, recognition of worker values and minimal inventories, and a competitive manufacturing strategy. Buffa's six basic manufacturing strategies enabling a modern firm to compete are:

(i) production systems that match product life cycles with production;
(ii) manufacturing capacity and location decisions;
(iii) modern production and process technologies;
(iv) worker empowerment and long term employment;
(v) simplify planning and control systems and operation decisions;
(vi) recognise value of suppliers and the supply system.

Shetty and Buehler's eds. (1987) augments Buffa's reasoning for reversing the declining productivity of Western firms through seven changes: new capital investment, improved labor-management relations, reduced government regulations, revitalizing and restructuring corporate management, increased emphasis on manufacturing management, increased innovation, and improved productivity and quality.

Michael E. Porter believes that seven themes have emerged in international competition. These themes are applicable to changing symbiotic relationships because they establish the need for change, the

emphasis interactions with various governments, and the necessity for strategic planning. Porter's seven themes are:

"1. There is no one pattern of international competition nor one type of global strategy. ...Sometimes an international industry is nothing more than a collection of largely separate domestic industries.

2. The globalization of competition has become the rule rather than the exception by 1986. ...The particular forces driving globalization as well as the resulting patterns of competition vary widely from industry to industry.

3. The nature of international competition has changed markedly in the last two decades. ...The changes in international competition have affected every functional area; and historical ways of doing things, as well as research based on earlier periods, are no longer sufficient to guide today's strategic choices. Many firms are prisoners of their history, however, which makes new lessons difficult to learn.

4. Coordination among increasingly complex networks of activities dispersed worldwide is becoming a prime source of competitive advantage. In each functional area of a firm, whether it be finance, marketing, production, or R & D, the need to coordinate activities in different countries has become an imperative.

5. Governments are increasingly both promoting and protecting against global competition, requiring new approaches to government relations. ...In the process, governments are also competing among themselves to attract foreign firms.

6. Global strategies frequently involve coordination with coalition partners as well as among a firm's own subsidiaries. ...The firms who can make international coalitions work will have an important edge in international competition.

7. Implementing a global approach to strategy requires a difficult organizational reorientation for many firms. ...The solutions arise as much from attitudinal changes, education, and organizational processes as they do from formal reporting relationships."[7]

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7. Michael E. Porter, ed., 'Competition in Global Industries', (Boston: Harvard Business School Press, 1986), pp. 5-7.

Five factors affecting a firm's competitive performance, and consequently its operational profile, are found in the study by Baker, Black and Hart (1988): (1) marketing, (2) environmental, (3) organisational, (4) strategic, and (5) managerial. This study finds the higher performing firms have an active interest in marketing by the upper management levels. Management of these firms perform strategic planning based on measurable objectives of product and market development, and keeping a long-term perspective.

Bradley asserts that company management is facing a strong strategic shift away from the traditional customer and product orientation, because of increased pressures from the external environment. The external environment includes competition, trade unions, government regulation, availability of resources, level of industrialisation in the country, the education system, and culture, including the work ethic. Bradley cites Simon and Wind, and Robertson "...that the firm must cater for its customers within the context of the firm's environment." (Bradley, 1985, p. 3; agrees with Porter, 1980).

Bolwijn and Kumpe (1990) in analyzing characteristics of major manufacturers' competitiveness, conclude that the triad of price, quality and products are insufficient for the 1990's. They believe that, to be competitive: innovativeness will be the new market demand; products will have to clearly stand out from those of competitors. The authors conclude that competitive firms in the 1990's will compete simultaneously on four fronts: efficiency, quality, flexibility and innovation.

Bamberger's (1989) research on small and medium-sized firms discusses the role of distinctive competences in developing competitive advantages. He argues that specific resources and skills such as modern

equipment, skilled workers, efficient information systems and good management are instrumental in developing competitive advantages.

4.2.2 Global environment

Modern Western industry is truly a global player when considering its marketing efforts, procurement decisions, labour, and raw materials sources.

Many Western industries, because of international competition, are global in their sphere of operations. For example, airframe and aero-engine assembly, supplier base, customer (airline) base, raw materials, and government regulations are global in their location, endo- and exogenous effects, and ultimate influence upon the civil aerospace industry. (Newhouse, 1983, Reed, 1973, Standard & Poor's, 1992.)

Manufacturing competition is global in nature with major assemblers in North and South America, Western and Eastern Europe, Australia, the Near-East, and the Far-East. (Todd and Simpson, 1986.) The component and material suppliers are even more geographically disbursed than the assemblers, with virtually every country that has begun to industrialize having tiers of component suppliers to the electronic, automotive or aerospace industries.

The customer base is world wide and is gradually shifting from advanced industrialised countries to newly industrialised countries. Consequently, marketing strategies and emphasis must reflect this global shifting of the customer base.

The governments of many countries are deregulating their communications, utilities, transportation and farming industries to comply with regional (e.g., EEC) regulations or to meet competitive threats. First, deregulation changes the number of customers available to an industry because smaller companies can more easily enter with lower threshold costs; and second, it changes the type of equipment purchased by the

existing traditional markets. For example, a small local utility has different equipment needs than one servicing an entire geographical region, or a regional airline has different aircraft needs than an international carrier.

Production and global procurement methods are changing in response to increased competition by fewer assemblers. For example, the introduction of new products or models forge a new consortium of major and minor component suppliers who may be competitors on other models. Another example of changing procurement methodology is the complete sub-contracting of major assemblies and components, perhaps with design authority and contract administration responsibility assigned to the primary supplier.

4.2.3 International activity

International activity literature is further classified into (1) advantages of internationalisation, (2) internationalisation of the firm, and (3) international behaviour of management. Each of these are briefly explored below because they address the issue of changes being forced upon Western businesses to survive in an international economy:

(1) Advantages of internationalisation

The primary advantages of internationalisation are: increased sales of specific products or complementary product lines, diversification of markets and products for achieving stability, desire for profits, competitive positioning, safeguard against a slow-down or recession in the local economy, use of excess manufacturing capacity and reduction in distribution costs. (Rabino, 1980; Cavusgil, 1984.)

Cavusgil in his study of seventy midwestern U.S. manufacturers finds another advantage of internationalisation: "Many of the executives of committed exporters were blunt about the fact that their domestic market was mature or declining, and that exporting was their only source of real

growth."[8] This finding is supported by Schlegelmilch and Crook (1986) in their conclusion that a primary motive for exporting is a saturated domestic market amongst British firms. (Supported also by Cannon, McAuley and McKay, 1988.) With the shrinking number of major aerospace assemblers, the component suppliers are increasingly faced with this declining market factor.

In addition to the primary reasons discussed above, there are several secondary reasons for Internationalisation appropriate to this study. Rabino (1980) finds secondary reasons for internationalisation that are supportive to the primary reasons stated above:

(i) going overseas presents the firm the opportunity to market a mature product or to utilise excess production capacity;

(ii) meeting the competition head-on; and meeting dealer's and customer's 'expectations' of an international image;

(iii) feedback of intelligence and performance data that enables the firm to improve their product or to pursue new product development.

(2) Internationalisation of the firm

The second international strategy is derived from the aspects of the firm. Porter (1986) discusses the distinction between two key dimensions of international competition: the configuration of a firm's activities and the coordination of linked activities. Configuration, simply stated, is how the firm's assets, capabilities and strategies are positioned worldwide to serve the international markets targeted. Coordination is the determination of extent of interaction of production, marketing and distribution, as compared with non-coordinated autonomous operations, allowed each facility worldwide. (Paraphrased from source.)

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8. Tamer Cavusgil, 'Differences Among Exporting Firms Based on Their Degree of Internationalisation', Journal of Business Research, 1984, V. 12, p. 201.

Companies that export also tend to engage in other international business activities. (Withey, 1980.) Withey reports that forty-nine percent of the exporters import raw materials or supplies, compared to fifteen percent of the non-exporters. He also finds that twenty percent of the exporting small manufacturers operate production facilities outside the United States. This may be partially explained by the decision to operate off-shore assembly and production facilities in the Pacific Rim countries for reasons of cost competitiveness.

The size of the firm and its effect upon involvement in exporting is found to have significance by Kaynak and Stevenson (1984). Their observation is that eighty-three percent of the non-exporters are smaller than five million dollars in gross sales, with sixty-five percent smaller than one million in annual gross sales. This observation raises the issue of having expert staff in-house facilitates exporting, or conversely, do firms with knowledgeable staff also export? This issue is not pursued in this dissertation. Apparently in contradictory observations to Kaynak's et. al. observations, the respondents to Abdel-Malek's survey indicate "...smaller firms seemed inclined to be more active than larger firms in seeking or developing export business." (Abdel-Malek, 1978, p. 27). Abdel-Malek attributes this active seeking of internationalisation to the positive impact of technology on the smaller firm and the increased domestic competition faced by the SMEs.

(3) International behaviour of management

The third international strategy is from the viewpoint of management. Perception of benefits is a significant influence on the manager's decision-making process about international strategy. The perceived strengths of the various methods of internationalisation, the perceived strengths and weaknesses of management, staff and resources available within the firm,

and the perceived exogenous environment within which the firm is operating are important influences upon the decision maker. (Bilkey, 1978; Reid, 1981; Burton and Schlegelmilch, 1987.)

Roy and Simpson (1981) find that management must develop an 'export oriented mentality' to succeed in international markets. Suzman and Wortzel (1984) expand this concept to include four requirements which are appropriate to attain success in internationalisation:

(i) top management commitment in substance as well as in fact,

(ii) commitment to maintain a visible presence in the market,

(iii) commitment to supply the needs of the market, including production capacity set-asides; this is particularly appropriate for surge capacity needs of major aerospace manufacturers, and

(iv) commitment to maintain realistic pricing, which becomes an intricate part of just-in-time purchasing and supplying interface.

Suzman and Wortzel, while agreeing with the above findings, carry their conclusion further, stating that the manager's commitment must successfully be communicated within the organisation. "Regardless of the firm profile or strategy, there are certain other requirements that a firm must satisfy if it is to be successful. The most critical requirements for the success of any export strategy are top management commitment and the clear, unambiguous communication of the commitment by top management to all relevant parts of the organization."[9] The authors continue on to stress the importance of maintaining a visible presence in any markets entered and to continually supply the export market through long-term production set aside. (See also Small Business Report, 1987; Kaynak et.al., 1987; Porter, 1986.)

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9. Cedric Suzman and Lawrence Wortzel, 'Technological Profiles and Export Marketing Strategies', Journal of Business Research, June, 1984, p. 192.

Beamish and Munro (1987) discuss the ongoing commitment to internationalisation that is necessary for a sustained commitment to global operations. They find a high intensity of export sales to total sales when there is a larger proportion of staff primarily in exporting, high proportion of manager's time devoted to exporting, and high proportion of export employees to total employees.

The common exogenous influences upon management's attitude towards internationalisation include increasing domestic and foreign competition upon home markets, the limited home market expansion opportunities or the extent of real growth in the industry at home. The exogenous considerations are considered at both the micro (firm) level and the macro (strategic) level by the firm's management. (Rabino, 1980; Cavusgil, 1984; Schlegelmilch and Crook, 1986.)

5.0 GOVERNMENTS' INFLUENCES

One of the more significant environments faced by industry is the multiple interactions with governments. The plural term 'governments' is deliberately used because in almost every case several different countries are involved, and several different layers of governments are involved within one country. The governments affecting participants includes host country, and those from their competitors, customers and suppliers' countries, when different, and national, regional and local within each country.

5.1 Multifaceted governmental influences

The first important concept that is apparent about governmental influence is its complexity.

The normal concepts of governmental assistance in export promotion, tax incentives, technology and innovations support, import - export financing, payment guarantees, and marketing assistance are not completely descriptive.

Other governmental involvement factors which must be considered are balance of trade effects, national pride, national defence, employment and locational aspects, and the large outlay of capital to bring a new product into production. (Todd and Simpson, 1986; Reed, 1973). Doz (1986) finds it not surprising, when considering all of these factors, that governments are intimately involved with modern industry either directly or indirectly.

5.2 Historical perspective

Historically, governmental programmes concerning industry have not been consistent in Britain and the United States, which causes short-term planning and reactive 'knee-jerk' decision-making by management. (See Reed, 1973; Newhouse, 1983.) For example, the impact of the military cutbacks in the early 1990's has dramatically affected the electronics, heavy equipment, repair and maintenance, food and civil aerospace industries, as well as the obvious armament and military aircraft and weapons industries. This flow-through effect from cutback of post-Gulf War military orders must be considered in conjunction with the continuing world-wide recession that affects industry. (Standard & Poor's, 1992.)

Both the U.S.A and West Germany have developed joint-ventures between government and private industry to train employees in TQM for small and medium sized enterprises. The German plan uses a trade school concept specializing in training young workers for manufacturing jobs emphasizing TQM procedures. The American approach is to use community

colleges (two year programmes) and State and Federal agencies for their TQM development. (O'Lone, 1990).

5.3 General government functions

Porter believes that governments deliberately "...promote concentration of activities by providing subsidies or other incentives to employ a particular country as an export base - in effect altering comparative advantage - a role many governments are attempting to play today."[10] He cites, as an example, India's governmental assistance to their indigenous software firms in becoming a world-class centre for software writing. Varied governmental direct financial aid packages and training programmes are designed to help India's software companies become state-of-the-art technologically and thus major international players in the software industry.

Yves L. Doz believes that governments intervene in globalization directly through regulation and indirectly through negotiations. "Control over trade policy is also a long-established government prerogative; debates between advocates of free-trade, mercantilism, and protectionism fill the literature on economic history."[11] Doz argues that governments often focus on specific issues regarding globalization:

(1) growth in trade results in economic adjustments;

(2) survival of independent national suppliers of strategic goods; and

(3) national concerns about strategic industries involving both defence and economic considerations.

The Scandinavian governments routinely assist in financing and procurement assistance with their internal companies, and encourage

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10. Porter, 1986, p.30.

11. Yves L. Doz, 'Government Policies and Global Industries', Competition in Global Industries, ed. M. Porter (Boston: Harvard Business School, 1986), p. 225.

piggy-backing of exports and mentor groups by not legislating them out of existence like the Americans historically have done.

5.4 Distinctive governmental influences

Several of the distinctive governmental influence factors upon the civil aerospace industry are location, innovation, policies and incentives, regulations, and information sources:

5.4.1 Location

The physical location of the manufacturing facility is generally found clustered in the traditional trading areas for each particular industry, around the major manufacturer, or where there is a skilled labour pool. Recent economic developments in Scotland and Wales support the view that persistent efforts by governmental agencies can change this trend by offering incentives for new plant start-ups or relocations to economically depressed areas. A recent example is the recruiting of Motorola to start a greenfield manufacturing facility near Bathgate, Scotland. The Scottish and Welsh success must be tempered with the realisation that they have a large pool of highly skilled labour located in high unemployment areas, while other countries may not have such comparable labour resources. (Mason, 1985; Miesenbock, 1988.)

Porter believes that governments play a proactive role in influencing firms to locate their entire 'value chain'[12] in their country through tariffs and other barriers, and nationalistic purchasing policies. He defines a value

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12. Porter's value chain consists of two main elements: (See section 2.6 for discussion.)
1. support activities - the firm's infrastructure, human resource management, technology development, and procurement activities; and
2. primary activities - consisting of inbound logistics, operations, outbound logistics, marketing and sales, and service.

chain as the integrated processes of raw materials, manufacturing and R&D at sites within the home or host country to the extent feasible.

Porter cites the Encarnation and Wells argument that governments compete against each other for hosting multiple national corporations' plant locations through various concessions and incentives. National, regional and even local governments compete for foreign investment by offering cash grants for training personnel and/or purchasing of capital items, greenfield sites, tariff protections and other inducements; e.g. Singapore and Ireland. Both of these governments are aggressively seeking new plants locating in their country, especially within the electronic industry, each offering a variety of incentives through international advertising in trade journals and the business press. (Porter, 1986).

5.4.2 Innovation

Cannon (1985) states that current governmental policies link small firms and innovation. The aim of the government is to assist in turning an invention into a commercially feasible product. Cannon's research indicates that the smaller firm's size, ability to make decisions and flexibility in manufacturing offset their possible lack of capital in bringing a new product to market.

The United States Small Business Administration (SBA) uses a grant programme to encourage small businesses to conduct R & D projects. The SBA found that twenty-five percent of the recipients of these grants had sold products based on their research within four years of receiving the grant. (Products reached commercial feasibility within four years.)

5.4.3 Policies and Incentives

Buckley et. al. (1983) discuss at length the impact of government policies on smaller firms locating in Britain. They conclude that tax incentives, capital allowances or other incentive schemes are rarely critical

to the location decision. This is in contrast to published reports by the Scottish Development Agency, which finds that training programmes, tax abatements and other money-saving schemes are important to new plant locations in Scotland. The differences in findings may partially be explained by the size of the firms choosing to locate in Britain; the larger firms are more aware of the various incentives. In addition, foreign firms seeking tax relief or locational advantages may more aggressively seek out these government benefits as compared to local firms.

Howard (1990) concludes that Japanese government assistance and 'partnership' in production and marketing policies, and outright financial assistance to smaller businesses, are decisive to Japan's rise to manufacturing eminence. Howard also argues that the extensive Japanese government network of national testing and research centres, staffed with consulting engineers, is another major factor for the success of smaller businesses in Japan. He cites similar networks in Italy, which combine governmental applied R & D centres, labour unions and entrepreneurs into an industrial district. These districts are responsible for organising production, sales, marketing, and some administrative functions amongst the independent manufacturers.

Eiteman and Stonehill (1986) discuss the implications of financial assistance by governments. The principal governmental plans are financing through an Export-Import banking system and through complete or partial guarantees of financial paper or loans. Governments may also offer special incentives for private export funding corporations by sharing the risk of non-completion or non-payment, forfeitures, or even financing. France and Germany have been active in financing arrangements for Airbus Industrie aircraft sales, often to criticism by their American competitors.

Several authors, particularly Porter, advocate that prevalent attitudes and environment give firms an all-important base to be successful in global operations. Porter terms this condition 'global platforms', which he defines as: "A country is a desirable global platform in an industry if it provides an environment yielding firms domiciled in that country an advantage in competing globally in that particular industry. ...An essential element in this definition is that it hinges on success outside the country,and not merely country conditions that allow firms to successfully master domestic competition. In global competition, a country must be viewed as a platform and not as the place where all a firm's activities are performed." (Porter, 1986, p. 39.) The classic country fitting this definition is Japan, with its well developed infra-structure and Ministry of International Trade and Industry (MITI) assisting global operations in several industries.

Seringhaus (1986) researched the impact of governmental marketing assistance upon exporting firms. He concluded that the proper roles for governmental assistance included standardised and customised market information and guidance, researching specific foreign markets, trade mission visits and trade fairs. His results indicated a support role for governmental assistance, not a direct financial partnership or incentive system.

Vozikis and Mescon (1985), concluded from their study of small exporters and stages of development, that governmental assistance is critical for success. They quoted a federal advisory committee that recommended direct financial assistance through funding start-up costs, providing financing at competitive rates, and providing outlays for marketing, product adaptation, and employee training. In the intervening years since this article appeared this message has been repeated by many authors, explicitly pointing to the Japanese assistance financed through MITI. MITI is

especially helpful in directing basic research and product development for Japanese industry.

5.4.4 Regulations

DeNoble et. al., (1988) discuss the barriers created by governmental agencies including their regulations and attitudinal impediments. They find that small businesses often perceive a complexity to internationalisation because of unfamiliarity with the regulations and financing availability. The authors believe that regulations are an effective trade barrier and export hurdle that can often be daunting to smaller businesses.

Daems (1990), while discussing the strategic implications of a United Europe after 1992, believes that a benefit will be derived by the SMEs because national regulations and laws will be standardised and harmonised. According to the author, the elimination of border controls and tariffs will assist the internationalisation process of small firms located within the EEC. Other benefits will be: packaging and safety law standardization, decreased transportation costs, commonality in size and content standards, and product specifications.

5.4.5 Information Source

Darling and Postnikoff (1985) list both the U.S. government and foreign governments as a source of information and determination of necessary product adaptations. They believe that this is an underutilised resource available to SMEs. (See also Edmunds & Khoury, 1986.)

Governmental agencies are often criticized for not disseminating necessary information to the firms that actually need it. In a contra viewpoint, Business America (1988), a quasi-government publication, gives an excellent overview of fifty firms that overcame their export problems, and shares their success stories with others. (See also Seringhaus, 1986, for support and informational role of governmental assistance.)

Reid (1984) argues that governmental information sources are not relied upon by smaller businesses because either:

(1) They are utilising special information sources or programmes which make governmental sources unnecessary; or

(2) The type of market knowledge and assistance provided is unsuitable for making foreign entry decisions.

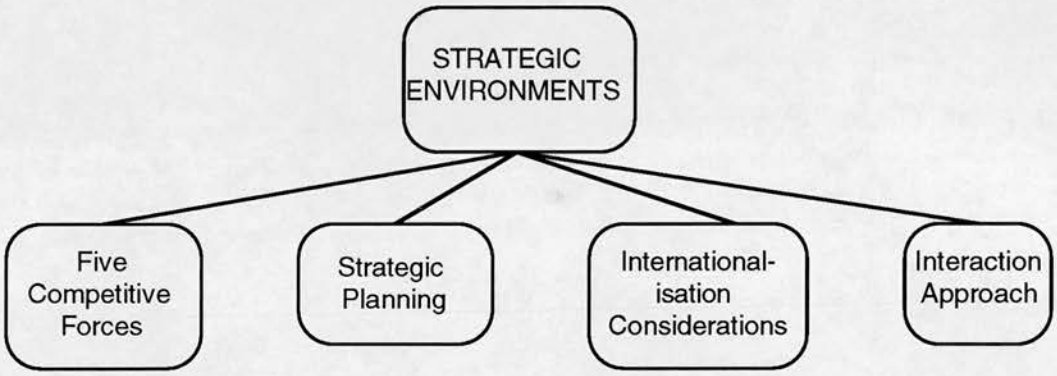
Dichtl, et. al., (1990) allege that the amount of support given by the exporter's embassy staff is a significant influence upon the success rate of exporters. The three German authors allege that the German embassies are particularly poor at providing information and export assistance, thus discouraging new exporters from going international. The authors believe that small and medium-sized firms must participate in fairs and trade shows overseas, receiving financial and informational assistance from their own government. This point has been particularly highlighted in the last two international airshows in France and Britain, where attendance by smaller firms has decreased due to the costs and economic downturn. The viewpoints above would have governments step into this attendance void by financially sponsoring SMEs to participate through partial or complete grants. This marketing expense factor is also affecting the major assemblers, e.g., BAe has decided to limit their participation to two major shows in 1993.

6.0 MEETING THE CHALLENGE - STRATEGIC PLANNING

Strategic planning and policies framed by global perspectives and undergoing continual change are supported by the business community, and influenced by both governmental and global/international environments as previously discussed.

The strategic environment that participating firms operate within is further classified into four areas: (i) Porter's five competitive forces, (ii) strategic planning in general, (iii) internationalisation of the firm, and the (iv) interaction approach.

Figure One - Strategic Environments



6.1 Porter's 'Five Competitive Forces'

Porter (1980) asserts that "...the essence of formulating competitive strategy is relating a company to its environment." (p. 3; see also Bradley, 1985). He postulates five competitive forces which drives a firm to compete in its industry, and, within its underlying economic structure:

(1) Threat of entry - new entrants from other countries, e.g., aerospace work encouraged by MITI for heavy industries in Japan; or through new competitors within the firm's country.

(2) Threat of substitution - can be in forms of alternative choices or types of materials or technology.

(3) Bargaining power of buyers - the SMEs expressed considerable vulnerability to buyers.

(4) Bargaining power of suppliers - influence or bargaining power over major manufacturers' buyers. As a group suppliers may have considerable power over a major assembler, but loosely organized trade associations etc. may not give power to the suppliers.

(5) Rivalry among current competitors - Porter believes that competitors are mutually dependent. Mutual dependency is defined by Porter as competitive moves by one firm having noticeable effects upon other firms competing in that industry.

6.2 Strategic planning

The symbiont change process is a conscious decision that requires various degrees of strategic planning by the participants. The general planning parameters depend upon the endogenous and exogenous factors and environments operating upon, and within, the firm and its management. (See Bamberger, 1980)

Pearson and Gritzmacher (1990) classify the strategic management process into three phases:

i. strategy formulation process - with major variables;

ii. strategy implementation and objectives - with key activities; and,

iii. strategic controls and monitoring techniques.

Nutt (1989) finds that if managers select specific tactics to implement their strategic plans their success rate increases significantly. He developed and field-tested an intervention-managed process that used situational limitations and a decision tree for manager choices.

Several authors question whether smaller firms do actual strategic or even formal planning routinely in their decision-making process. (Kaynak et. al., 1987; Bamberger, 1980). Secondly, other research termed 'strategic group analysis', questions small firms' use of strategy and types of strategy leading to export success. "The current trend in strategic management research is to classify firms by strategy type or group, and then to identify successful strategy types within a given industry or set of circumstances." (Namiki, 1988, p. 32).

Both of these questions are answered by Namiki who concludes that small firms using a specific strategy will have a tendency to outperform those firms that do not use strategic planning. Namiki's findings conclude that

small firms do strategic planning, perhaps more intuitive than formal in nature, but present.

Four different orientations of competitive strategy, in empirical research conducted by Namiki, are utilised by sixty-three smaller American computer hardware firms (researcher's note: the electronics industry has many similarities with the aerospace industry - high technology, extremely competitive, global sphere of operations, large number of component suppliers not grouped around the manufacturers, and skilled labour force):

(1) Marketing orientation - pricing, brand identification, distribution control, advertising and innovative marketing techniques;

(2) Differentiation focus - specialty products, broad product range, new product development for specific groups;

(3) Innovation orientation - technological superiority and new product development in general; and

(4) Product oriented - customer service and high product quality.

The existence of strategic planning by small businesses is supported by Namiki's study, and the author observes that certain strategies outperform others. (See also Howard & Herremans, 1988; Darling & Postnikoff, 1985; Leaversuch, 1988).

Bamberger (1980), in his contingency theory of planning by smaller companies, asserts that planning systems are determined by their context. He suggests that the essential property of strategic planning is the systematic and comprehensive search and transformation of information. Bamberger argues that the smaller entrepreneur, being closer to the facts and using more intuition, may make fewer errors than its counterparts in larger businesses. "The planning process which is hardly formalised, relatively global, but systematic and explicit need not be a disadvantage but

can prevent several planning pathologies."[13] Reynolds, Lindstrom and Despres (1994) find that high performing firms acquire and utilize external information, while lower performing firms either do not acquire the information, or make little use of such information gathered.

Reid introduces a strategic planning concept that "...foreign entry and expansion behaviour may be the product of complex interactions between firm and decision-maker variables, ...".[14] He contends that the smaller firm is more affected by the individual decision maker's progression through a five stage strategic planning process consisting of:

(1) awareness stage - consisting of the potential market opportunity recognition or possible solution of an existing domestic marketing problem;

(2) intention stage - involving motivational and attitudinal factors which affect type of foreign market entry, attitudes towards foreign countries, customers and commitment of resources;

(3) trial stage - involves responses to foreign orders or initial export engagement through trade fairs or visits to foreign markets;

(4) evaluation stage - evaluations of initial export activities including profitability and sales stability;

(5) acceptance/rejection stage - decisions made from trials and evaluations measured by such factors as firm growth, absolute level of exports, relative growth of export sales, rate of new market expansion, and rate of new product introduction into foreign markets.

Cooper and Kleinschmidt (1985), without drawing conclusions about direction of causality, also associate marketing strategy and world orientation with export performance. In addition, they find that the relationship between export marketing strategy and export growth is also strongly significant, as is export intensity to the export strategy elected.

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13. Ingolf Bamberger, 'Business Policy Planning in Small and Medium Sized Firms', Management Information Review, V20, N. 1, 1980, p. 36.

14. Stan D. Reid, 'The Decision-Maker and Export Entry and Expansion', Journal of International Business Studies, Fall, 1981, p. 101.

Cavusgil and Nevin (1981a) realistically contend that management must assume a long-range commitment towards internationalisation, and be rewarded based on their long-term performance, rather than the current vogue of short-term results. The authors' research concludes that international marketing behaviour can be substantially explained by four groups of internal and managerial characteristics:

(1) Expectations of management - the effects of exporting on the firm's growth;

(2) Level of commitment to export management - managerial and firm's resources;

(3) Differential firm advantages - size, technology, product; and

(4) Strength of managerial aspirations - for growth and security of markets.

Planning and cost analysis is a necessity for small subcontract firms in their competitive environment. Tobin, Mercer and Kingsman (1988), in their study of 24 firms preparing quotations for orders, find that the estimation process must include planning for costing, production processes, production control and pricing, all of which imply strategic planning by the owner or manager. (See Bamberger, 1989; Nutt, 1989.)

Leender, Fearon and England (1989) believe there are three major challenges in setting supply objectives and strategies. Their first challenge is understanding corporate objectives from the supply objectives viewpoint. Their second challenge is the actual choice of an appropriate action plan or strategy to achieve the desired objectives. The third challenge is to appraise the various supply issues in order to integrate them into future corporate and supply decisions.

An area of strategic planning often overlooked in the literature is the issue of international purchasing by smaller firms. Lars Hallen (1982)

researched this subject and found three factors which influenced international purchasing:

(1) The need for international purchasing due to current market conditions; (encompassing domestic availability);

(2) The desire to purchase internationally as evidenced by buyers' attitudes; (encompassing foreign trade policies, opinions, and quality of alternative sources); and

(3) The ability to execute international purchases administratively. (encompassing market knowledge, cultural awareness, foreign orientation and mastery of foreign languages.)

Heinritz and Farrell (1981) discuss the significant impact the energy crisis of 1973-74 had upon the purchasing policies of major assemblers and their suppliers. They believe that long-range shortages of materials, power of the oil cartels and the effects of greening policies beginning to be imposed upon raw material extraction industries, made companies rethink their shift away from long-term partnership arrangements with their suppliers as discussed by Bluestone et. al., (1981), and change once again toward non-adversarial policies. The authors also discuss the new responsibilities purchasing assume during the shortage years including new product development and long-range corporate planning functions related to materials acquisition and usage.

Flaherty defines manufacturing strategy "...as the broad plan by which a company or business unit develops, introduces, and manufactures products in order to satisfy customers' needs better than competitors."[15]

Flaherty further develops manufacturing strategy along two themes:

(1) Manufacturing configuration, which includes:
   (a) number, size and location of plants
   (b) technology and equipment choice

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15. M. Flaherty, 'Coordinating International Manufacturing and Technology', Competition in Global Industries, M. Porter, ed., (Boston: Harvard Business School Press, 1986.) p. 86.

(c) assignment of materials, components, and products to be made by specific manufacturing facilities
(d) vertical span of the manufacturing process

(2) Support activities policies
(a) policies for manufacturing support activities
(b) policies for technology support activities

Although the principles of Flaherty's research are more appropriate for the major manufacturer, many of them are applicable to the small and medium-sized component suppliers as well. Particularly appropriate for the SMEs principles are the general manufacturing or procurement areas of coordinating procurement, production planning and manufacturing engineering.

Pogue (1990) argues that strategic management accounting has a mandate to provide necessary information to management for them to achieve their objectives. He believes that successful formulation and implementation of strategic objectives depends on their being clearly stated, capable of being measured, and attainable with effort.

All of these strategic objectives are dependent upon the quality and timeliness of information provided to management through the accounting process in a useful format.

6.3 Internationalisation

The third strategic environment discussed in this section is internationalisation.

Internationalisation is designated an important strategy in this study because of its impact upon the small and medium-sized component suppliers (SMEs). The SMEs are confronted with global sourcing policies of a limited number of major manufacturers, as well as global purchasing

necessitated by specific demands placed by these manufacturers or their international customers.

Porter (1986) advocates four broad types of overall international strategy: (Porter's paraphrased terms are in italics)

(1) *Global cost leadership or differentiation* - cost leaders tend to market standardised products across the major industrialised countries, while product differentiation firms offer model variation and frequent changes as their trademark.

(2) *Global segmentation* - targets the advantages of a narrow segment of a particular industry and focuses its attention on this segment worldwide.

(3) *Protected markets* - seeks out countries that have high impediments to foreign entry; usually infers high domestic content in the product. Once market share is obtained, it is relatively safe from new foreign competitors.

(4) *National responsiveness* - competing in countries where unusual market needs are significant in size, e.g. the large motorcycle market in the United States.

Porter believes that the appropriate unit of analysis for planning international strategy is at the industry level. He differentiates between two basic types of international competition:

(1) multidomestic industries (e.g., consumer banking) whereby each country has an autonomous industry but they can be combined into a portfolio type of investment; and

(2). global industries, are ..."an industry in which a firm's competitive position in one country is significantly affected by its position in other countries or vice versa. ...In international competition, a firm has to perform some functions in each of the countries in which it competes. Even though a global competitor must view its international activities as an overall system, it still has to maintain some country perspective. It is the balancing of these two perspectives that becomes one of the essential questions in global strategy"[16]

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16. M. Porter, 1986, p. 18.

The more common form of international strategy as typically found in small and medium-sized enterprises, is direct exporting. This is followed by importing of raw materials or components, and then overseas sales subsidiaries. (Withey, 1980).

6.4 The Interaction Approach

The fourth strategic environment discussed in this section is the interaction approach discussed in the marketing literature since the 1970's. The essence of this approach is that product development in industrial markets is best described from a network perspective in which manufacturers and their customers actively participate within the product development and manufacturing paradigms.

Biemans (1992) argues that manufacturing relationships pass through three phases or models:

"1. Department stage models: The development if an innovation is traced by enumerating the departments through which it passes within the manufacturing firm.

2. Conversion models: The development process is depicted as a black box with several resources as inputs and the innovation as output of a conversion process within the firm.

3. Response models: The process of developing an innovation is regarded as a process of change, whereby a firm responds to stimuli from its environment."[17]

Because the interaction approach describes supplier-customer relationships, it greatly assists describing the civil aerospace interaction processes. For example, Biemans describes five stages of interactions

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17. Wim G. Biemans, 'Managing Innovation Within Organizations', London, Routledge, p. 64.

commonly found in the development of customer-supplier relationships. To paraphrase his description, stage one is considered the pre-relationship stage. The customer is growing increasingly dissatisfied with their previous supplier, whilst a competing manufacturer is increasing its marketing efforts trying to attract the customer to them.

Stage two is described as the early stage where the two parties begin preliminary negotiations, develop specifications for the product and essentially seek additional information about the other party to see if they want to consummate the contract.

Stage three is the development stage where the contract is signed, both parties are committed to the new relationship, and formal and informal adaptations to their behaviour are beginning to be made.

Stage four is the long-term stage where the relationship matures because of the firms' importance to each other and they have acquired considerable experience with each other. This stage is witnessed by extensive formal and informal adoptions of practices and behaviour towards each other, normally mutually beneficial. Ford (1990) describes this stage as the links between the buyer-seller relationship formalizing into a set of roles involving a complex pattern.

Stage five is the final stage where both parties have developed stable market for their products and they have a long-term perspective of continuing business with each other.

Ford (1990) believes the interaction model divides into four components, the interaction process, the interacting parties, the interaction environment and the interaction atmosphere. These components complement Biemans five stages and assist in explaining the advantages of this theory. In essence, he adds two considerations, the environmental and atmosphere interactions. The interaction environment is concerned with the

dynamics and relative positions of the participants to the interaction. The interaction atmosphere concerns the attitude and mental images concerning the control dimension of the interaction.

Biemans and Jones each believe their approaches focus on cooperating in developing industrial products, particularly in technological innovations or complex markets. This is one of two observed weaknesses of the theory as applicable to the aerospace industry, in that the entire industry is technologically advanced, therefore all of the players are expected to also be technologically advanced. This argument is based on the premise that the players are less dependent upon each other if both are technologically advanced.

The second weakness of the interaction theory is that it focuses almost exclusively on the supplier-customer relationship, and does not look forward and backward along the industry network. For example, in the civil aerospace industry, the relationship between the major assembler and its component suppliers must look downstream to the ultimate customer, the commercial airlines, as well as upstream to the suppliers of raw materials, many of whom are as large or larger than the major assembler.

However, given these two observed weaknesses, the interaction approach adds to the understanding between the major assembler and its component suppliers and increases their chances for remaining competitive in meeting the strategic planning objective of global competition. The supplier-customer relationship assists in explaining cooperation between competitors in a horizontal competitive situation, where for example, two major assemblers are competing for the same customer but form an alliance for a specific aircraft model. The interaction approach is also useful in illustrating relationships in a vertical manufacturing situation, such as found in Japan, China, France, or Germany, where layers of suppliers cooperate in

the development of a technologically advanced product. This interaction amongst vertical manufacturers is considered as a critical part of lean production techniques by Japan's MITI.

7.0 CHANGE

7.1 Planned change

Thomas and Bennis define planned change as "the deliberate design and implementation of a structural innovation, a new policy or goal, or a change in operating philosophy, climate, or style."[18] Stoner and Freeman (1992) distinguish between planned changes and reactive changes by the organizational aims preparing for significant change in policies, goals or philosophies. They state that there are least three primary reasons for change:

(1) The organization's survival is threatened by external environmental changes - losing touch with their environment.

(2) Environmental changes can offer an opportunity for new business or increased profitability. The authors feel that this perspective is the hallmark of the successful entrepreneur, even within large corporations.

(3) The organizational structure is the problem, not allowing the entity to react to its changing environment in a timely manner, in effect becoming a victim of its own success.

Stoner and Freeman advocate three approaches to planned changes: alteration of an organization's structure, technology or its people. The authors emphasize the point that organizations are complex, interactive and interdependent, therefore any changes of magnitude will be more effective if they involve several or all three of the approaches. The author's

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18. John Thomas and Warren Bennis, eds., 'The Management of Change and Conflict', Baltimore, Penguin, 1972, p. 209.

conclusions seem to support Williamson's transaction cost analyses discussed earlier.

Klein (1990) modifies the above three approaches to change for operations management as changes in technology, structures and systems within the manufacturing organization. According to Klein, new technology looks at the impact upon the workplace and organization by using computer-aided-design, (CAD), computer-aided-manufacturing, (CAM), computer-integrated-manufacturing, (CIM), and flexible-manufacturing-systems, (FMS). The purpose of structural changes is to align human resource policies with measurement systems, organizational structure and job design. New systems include total quality control, statistical process control, just-in-time and group technology.

To make changes, Cavusgil and Godiwalla believe the effects of information upon decision making must first be determined. Their premise is subjective factors have an important effect on the decision-maker as well as the firm. Their first argument, that decisions are not made in a fully rational mode because of lack of information, small number of alternatives, and presence of uncertainty, affects the rationality of the decision. Their second subjective factor is that the key decision-maker is often hampered by the quantity and quality of objective information, which is generally limited in international ventures. (Cavusgil and Godiwalla, 1982).

The authors, Cavusgil and Godiwalla, believe that management operates under environmental uncertainty, which results in a disjointed, adaptive and incremental decision making process. Their findings do not underplay the importance of the decision-maker, but emphasise the likelihood of basing decisions on intuition of management, which may be to the advantage of smaller businesses. (See also Bamberger, 1980; Reid, 1981).

One proposed solution to this environmental uncertainty is suggested by Cannon et. al., who discern that it is the endogenous "...'internal-driven developers' aim to build a skill resource and knowledge base within the company. This will, in turn, facilitate growth and the exploitation of international and other opportunities."[19] This internal-driven developer is analogous to Bilkey's internal change agent in motivational concept and goals for the company. Stoner and Freeman's third change factor, the firm's personnel, also supports this argument in that a focus must be made on "skills, attitudes, perceptions and expectations" (p. 416) to achieve change in organizational employee behaviour.

Another alternative, which supports Cavusgil and Godiwalla, is raised by Reid (1984), who emphasizes the acquisition of information by small firms in their international strategy decision-making. He advocates the personal information networks and data-gathering systems of the owners as a key determinant in their final decision-making. This data gathering, both formal and informal, leads to increased tactical and strategic information useful for decision making and planning purposes.

"Many firms are prisoners of their history, however, which makes new lessons difficult to learn." (M. Porter, 1986).

Michael Porter illustrates change activities using a 'value chain' model that has five levels of activities operating through five factors, or forces, horizontally driving changes within the enterprise.

Figure Two - Porter's Value Chain (following page)

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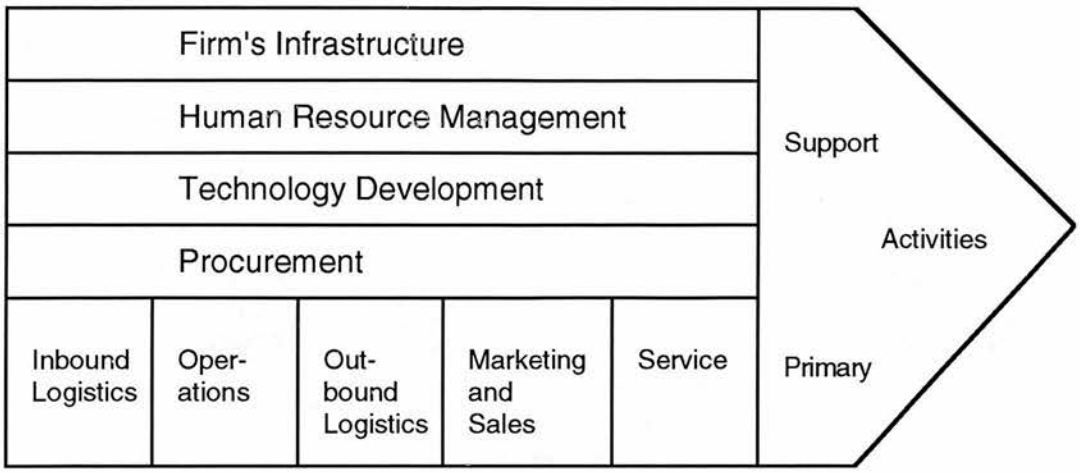
19. T. Cannon, A. McAuley, and J. McKay, 'Internationalisation and the Role of Marketing', Occasional Papers Series n.25/88, University of Stirling, August, 1988, p. 4.



Porter's value-adding activity levels are presented in two general categories:

a. Category one - levels of support activities, consisting of:

(1) The firm's infrastructure which includes general management, accounting, finance, strategic planning and other general support activities.

(2) Human resource management includes recruiting, training and development of personnel.

(3) Technology development is involved with research and of products and " .. creating and improving the way the various activities in the value chain are performed." (p. 20)

(4) Procurement is the obtaining of all the necessary inputs, including raw materials, services, capital equipment, parts and components.

b. Category two - level five, primary activities, which are involved in the physical creation of the product or service, delivery, marketing and after sales service: (1) Inbound logistics, (2) Operations, (3) Outbound logistics, (4) Marketing and sales, and (5) Service.

Porter makes a distinction between 'upstream' and 'downstream' value activities of these five forces and their separate service layers. He categorizes upstream value activities as inbound logistics, operations, and

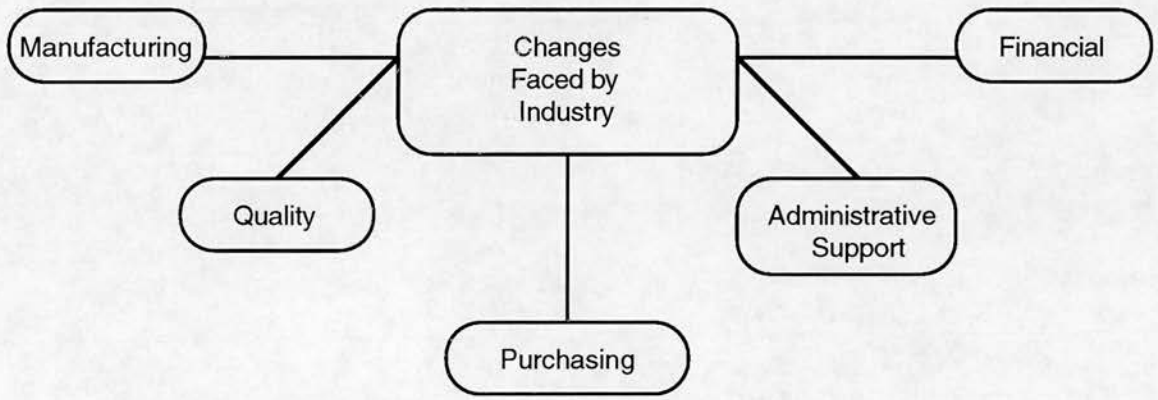
part of outbound logistics. Porter includes in downstream value activities part of the outbound logistics, marketing, and service forces.

Porter's inbound logistics, operations and outbound logistics support not only the internal linkages within a firm but also the increasing dependence between firms connected by the supply linkage. This value chain supports the theory that symbiotic relationships are increasing because of the aforementioned changes taking place by both participants in industry - the major assembler and their component suppliers.

7.2 Procedural changes

The specific areas of procedural change discussed in this literature search are manufacturing, quality, purchasing, administrative support systems, and financial aspects.

Figure Three - Changes Faced by Industry



7.2.1 Manufacturing changes

JIT manufacturing techniques have become a popular catch-phrase in many industries, and unfortunately, subject to some misunderstanding. Lubben describes JIT as "...the term is meant to convey the idea that the three major elements of manufacturing - capital, equipment, and labor - are made available only in the amount required and at the time required to do

the job. ...Because the development of high-quality processes and products is the responsibility of the entire company, and not just a single function, the word manufacturing includes all responsible functions in the company (i.e., engineering, production, sales, finance, quality, etc.), not just production."[20]

Lubben further defines the goal of JIT manufacturing, which is to eliminate any non-value adding function in the manufacturing system which burdens overheads, impedes productivity, or adds unnecessary expense to an operating system. (Paraphrased from Lubben, 1988, p. 8). His five basic principles for developing a JIT systems are:

"1. Each worker or work unit is both a customer and a supplier.
2. Customers and suppliers are an extension of the manufacturing process.
3. Continually seek the path of simplicity.
4. It is more important to prevent problems than to fix them.
5. Obtain or produce something only when it is needed (just in time)."[21]

The change towards JIT manufacturing techniques creates tensions and potential problems within an organizational, which can be partially mitigated through planning and communication efforts. Brown and Mitchell (1991) researched the effects upon employees and their perceptions during a manufacturing conversion from traditional batch processing to JIT techniques. After JIT conversion, the employees perceived fewer problems with parts and work-related information, but more problems with scheduling and reliance on co-workers. The obstacles encountered by this group seemed related to the computer system and corresponding information flows, or lack of flows. Apparently these obstacles could have been

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20. Richard T. Lubben. 1988. 'Just-In-Time Manufacturing, An Aggressive Manufacturing Strategy'. New York: McGraw Hill Book Company. p. 4.
21. Ibid, p. 8.

prevented with better training and conversion preparation, and perhaps more resources devoted to the conversion.

James (1990) argues that off-shore placement of manufacturing creates a 'hollowing-out effect' not only upon the firm, but, also affecting national considerations. He believes that this creates a skills void, which he terms as 'atrophy'. James suggests that this skills atrophy causes firms to lose their competitive edge and skills base, further spiraling them into competitive disadvantage.

7.2.2 Quality changes

W. Edwards Deming bases his theory of management on the foundation of quality, and of continual improvement throughout the product life cycle. His well-known fourteen points of management philosophy covers not only quality and continuing improvement, but also training, leadership, breaking down of barriers, motivation, and, surprisingly for a statistician, keeping numbers in perspective. All of Deming's observations and recommendations point out that only management can change the system; which is why he refuses a consulting engagement unless the request comes from the CEO. Deming believes that management is responsible for continual improvement (quality) of the extended process and must understand three types of quality:

(1) quality of design and redesign - meeting the consumers needs by looking ahead into the future;

(2) quality of conformance - the extent a firm and its suppliers are able to surpass the design requirements necessary to meet the customer's needs;

(3) quality of performance - determination through research and service calls on how the product is performing in the marketplace.

All of these quality controls are monitored by statistical techniques and managed through process controls. (Gitlow et.al, 1987; Walton,1986.)

Quality control assurance and management reduce manufacturing costs and impacts sales directly in two ways, according to Shetty and Buehler (1987).

(1) Cost of manufacturing is reduced by good quality because:

(i) of decrease in labor and machine times;

(ii) of decreases or elimination of scrap; and

(iii) warranty claims are decreased, saving service calls and replacement parts, as well as shop labor.

(2) Product reliability and reputation will impact sales

World class manufacturing (WCM), as termed by Schonberger (1982), approaches quality management differently than traditional methods. The WCM model places management's emphasis on the solving of problems that cause poor quality, rather than the 'fire-fighting' technique of tackling poor quality itself. (Maskell, 1989). Maskell proposes that to accomplish this goal, quality has to be designed into a product and a change in manufacturing attitudes instituted towards an awareness of quality issues in the manufacturing process.

Burt (1989a) establishes requirements for managing product quality through strategic purchasing. He feels that engineering plays an important role by designing quality into the product. Burt also advocates having suppliers participate in the design process, and he recommends periodic value engineering reviews during the product life cycle.

The more traditional quality improvement approaches, as advocated by Deming, Juran and Crosby, place emphasis on the people involved, management credibility, and training. King, in his article about how the 3M company melds Deming's commitment to a training program in statistical quality controls, Juran's quality management, (especially with vendors), and Crosby's quality emphasis training, emphasizes the necessity of

commitment by top management as the first step. 3M also utilises Ishikawa's quality action teams and quality circles, and uses quality audits to ensure the policies are being carried out in both company systems and field performance. (Chapter in Shetty & Buehler, eds. 1987.)

According to Graham, Texas Instruments integrates three quality improvement programs into its service and product areas: (Article in Shetty & Buehler, eds. 1987)

(1) Measurement of quality - uses parts-per-million (PPM) instead of percentages; this places everyone on a scale with an absolute zero. Every manager is placed on a quality measurement and is evaluated on their quality performance in an annual letter.

(2) Training programs must be significant and continuing.

(3) Supplier quality monitoring and measurement - must show an improvement in incoming lots.

Lubben (1988) discusses the reversal of the post-war practices of separating quality assurance from production to returning quality responsibility to the production function. Lubben advocates that non-value activities such as quality assurance are a result of inadequacies in the manufacturing system. Therefore the overall health of a company can be measured by the extent on which these activities are utilised. For example, quality assurance corrects mistakes made in the production process, the extent of reliance upon this department reflects upon the performance of the production process.

One of the mainstays of TQC is the concept that price is not the overriding factor in purchasing decisions. Burt (1989b) contends that the cheapest product is not necessarily the best; quality considerations must be considered as part of the total delivered cost. Quality problems can increase downtime on the assembly line, require modifications during the assembly

process, cause rework, scrap, and warranty problems, and increase legal exposure.

Major manufacturers (and governmental agencies, especially in defence work) have traditionally rated component suppliers for quality performance and compliance. This rating system is being expanded to include delivery performance, defect resolution, flexibility in build and adjustability to schedule changes. Many of the component suppliers are also rating their own suppliers in a similar fashion. (Interviews with major manufacturer and component suppliers.)

7.2.3 Purchasing changes

Lubben (1988) connects quality assurance with purchasing contracts and relationships through the media of communications. He believes that most quality-related problems are a result of poor communications in the purchasing relationship. He places the responsibility for supplier quality squarely on the purchasing department.

Segal (1989) is one of few authors to mention symbiotic relationships between firms in his article about implications of single vs. multiple buying sources. Segal discusses the strategic importance of the symbiotic and personal aspects of the buyer-seller relationship in a single-sourcing situation. He found significant purchasing criteria differences between purchasing managers from firms preferring single sourcing from those preferring multiple sourcing of products or components. Webster and Wind (1972) address this reticence to change in their discussions about environmental influences on organizational buying behaviour. (See also Woodside et. al., 1977.)

Dion, Banting and Hasey (1990) reported extensive results of case studies on twenty firms using JIT industrial purchasing methods for at least

four years. Their research results are summarised below, indicating the number of firms experiencing:

prices decreasing slightly	50%
increased sales of other products to the buyer	90%
significantly higher product quality	60%
handling costs did not increase	75%
backorders declined	25%
lead times reduced	40%
damaged product occurrence reduced	40%
supplier delivery frequency increased	200%
buyer's complaints decreased	30%
firms' reducing number of suppliers	80%
firms' increasing size of orders	90%

The above findings indicate that the JIT principles of more frequent deliveries, fewer suppliers, increase in quality, and longer term contracts were significantly favourable amongst Dion's et. al. research respondents.

Pearson and Gritzmacher (1990) argue that the purchasing function has changed dramatically within the past decade and should be fully integrated into strategic planning. They recommend that firms make an in-depth review of their purchasing department and increase its level of professionalism and available resources. Their conclusion is that integrated purchasing changes have an important impact on the competitive position of the firm as well as financial consequences.

Komatsu heavy equipment manufacturer in Britain sends its engineers into its suppliers to improve their production methods and quality controls. With a sixty percent local content requirement for foreign firms operating in Britain, the suppliers must deliver on time and in expected quality to the Japanese firms based in Britain. (Oliver and Wilkinson).

7.2.4 Administrative support systems

The more frequently encountered accounting system changes are new methods for JIT accounting, review of costing procedures, paperless purchasing and electronic interface with suppliers and major manufacturers,

pricing changes to reflect changes in vendor payments, and allowance for time value of money in pricing.

To be useful, accounting information systems must adapt to new manufacturing environments. JIT manufacturing, delivery and purchasing methods have different information needs than the traditional methods many of the present accounting systems are designed to support. Even the method of costing products must adapt to the newer JIT methods of production and waste elimination. (Brimson, 1988; Cocker, 1989.)

One of the objectives in JIT manufacturing is to eliminate waste. Brimson argues that the current treatment of non-value added costs does not differentiate between value added and non-value added functions and waste control. He believes that the accounting system must provide this information to assist in waste management and establish performance measures for JIT manufacturing.

Cocker argues that management must be given JIT financial information for proper decision-making. He develops four areas of crucial needs for information to be developed for managements use:

(1) just-in-time material accounting,
(2) just-in-time labour accounting,
(3) just-in-time overhead accounting, and
(4) just-in-time accounting implementation and control.

Grinyer et. al., (1990) find that, in declining companies, poor financial controls were the third ranking factor in forty-five percent of the companies studied. The authors found that timing (either too late or too infrequently) and complexity of the accounting information were not appropriate for managements' use in decision-making. They also postulate that this process can be turned around and proper changes implemented by instigating proper financial controls and properly overseeing their usage.

Professor Robinson (1984) cautions the reader that "...talking about control without specifying the return on corporate assets committed, one is really talking about power, not about profit maximizing." (p. 16)

Beaujon and Singhal (1990) develop activity-based accounting system changes, as part of the infrastructure necessary to manage change, on "... three elements of an ABC structure that have a natural interpretation as activities: activity centers, cost drivers, and resource categories. (In designing these system changes) ...the designers of an ABC system affect how useful the system will be in managing activities (as opposed to product costs)." (Page 51.) The authors emphasize, and this researcher agrees, that the design of the accounting information system is crucial to the usefulness of the information necessary in managing change. The authors believe that recognition must be given to the new informational needs by managers operating under the changing environment.

Dent (1990) proposes that three possibilities of interaction exist between accounting, strategic planning and decision making. First, he considers the relationship between organizations' control systems and their strategies. Second, he considers the connection between accounting systems and decision-making. His third concern is between the proactive role of accounting systems and strategic change. Although his basic premise is that these are subjects of needed research, Dent's questioning of these subjects raises relevant points for managements' consideration and review.

All of the above management information system changes support the theories of symbiotic changing relationships because of the need for new and improved information. To obtain this information, closer relationships must be developed between the partners and within the organizations. The accounting system changes are one example of improving information.

7.2.5 Financial changes

Porter (1980) regards the need to invest large amounts of capital as one of six barriers to entry for new firms. Yosikawa, Innes and Mitchell (1989) describe a functional analysis approach to cost management that is pertinent to this section in that it addresses the identification of major components, suggests alternatives for improvements and recommends an interdisciplinary approach across functional lines and authority. Both of these authors address the needs for financial changes to support manufacturing and purchasing changes by both the major assemblers and their component suppliers.

Baldwin discusses four major factors affecting the cost of capital to a global corporation: (1) national capital market, (2) global capital market, (3) home government taxes and regulations, and (4) host government taxes and regulations. Although not all of these are always applicable to the SMEs, they do affect their contractors - the major manufacturers, and their customers. (Porter, ed., 1986)

The continual effects of the worldwide recession have serious impacts upon the companies' financial positions. The collapse of major customers, such as Air Europe in mid-1991, places financial stress on the manufacturers as well. CASA (Spain's state-owned civil aerospace manufacturer) announced in February, 1992, that it received a governmental $432 million capital infusion to assist it through the recession. Lessard comments about the increasing tendency of financial intervention in domestic economies by governments to favour home firms or domestic production. (Porter ed. 1986).

Cash flows, and the resulting continual need for their planning, is another operational aspect involving the resources of the firm. "Cash flows do not arise in isolation, they almost invariably arise as the result of the firm

undertaking some economic activity with expected net benefits." (Ashton, 1988, p.1) T. A. Lee argues that "If the needs of all the report user groups were to be reduced to a single factor it would be cash flow returns."[22]

Grinyer, Mayes and McKiernan (1990), in their research concerning turnaround companies (termed 'sharpbenders'), find that change often requires significant financial commitments for new equipment, processes, labour training and control systems. Their article is analogous to this research because of the explanation of capital and other resource commitments necessary for implementing changes. Beaujon and Singhal's article about the changing roles of activity-based cost systems indirectly supports Grinyer's et. al. arguments. These authors believe the motivation behind financial investments in alternative processes lies in an underlying desire to replace inefficient activities with efficient ones. Both articles recognise that limited resources are available to management, and that alternative choices amongst constraints must be made.

7.3 Changing Relationships

Symbiosis is fundamentally concerned with interactive relationships between the entities involved. This research studied the influence between a major assembler and its component suppliers, the interactions between purchasing and marketing personnel and policies, and the relationship with customers.

7.3.1 Influence of large manufacturers upon their component suppliers

Bluestone, et. al., (1981) describes the state of the subcontractor industry prior to 1980 as extremely perilous and dependent upon the

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22. Tom Lee, 'Cash Flow Accounting', Van Nostrand Reinhold (UK), 1984, p. 85.

policies of the major assemblers. These authors found that during the 1970's the majors preferred to use multiple sources of suppliers, constantly threatened to produce the components in-house (and in fact maintained that capacity) and cancelled contracts whenever sales declined. With the addition of a real threat of competition from Japan and other recent entrants to the market, foreign demand for co-production, and foreign offset sales agreements, the subcontractor industry participants decreased sharply from more than 6,500 in the U.S.A and Britain to less than three thousand by 1981. These findings were significant changes from industry practices during the 1950's and 1960's when single source suppliers were utilised, subcontractors were geographically grouped around the majors and "a largely symbiotic relationship prevailed between suppliers and the primes."[23]

(Editorial comment - this is one of the rare references in the literature to a symbiotic relationship between participants in the aerospace industry, or within any other industry. It is also ironic that this observation was made about the state of the subcontractor industry prior to 1960 before changes were made away from this bonding; in the late 1980's an apparent deliberate return is being attempted towards these symbiotic relationships.)

Bamberger believes that larger firms influence strategic planning of the smaller firms whenever there are many changes in product properties, distribution functions, or, when specialised market segments exist. Bamberger proposes a 'strategic categories' theory in which the SMEs utilise 'explicit problem-solving processes in the course of which alternative options for the firm's development are identified, analyzed and evaluated.' (Paraphrased from Bamberger, 1980)

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23. Bluestone, et. al., Aircraft Industry Dynamics, p. 76.

The current era of global competition emphasises standardised global products that are well-engineered, dependable, and competitively priced to meet the competitive environment faced in world markets. One strategic response to meeting the global competition is an increase in 'intrafirm trade' by multinational corporations. (Kotabe and Omura, 1988).

Additional critical points raised by Kotabe and Omura include that the rapidity of new product innovations abroad has accelerated, and that the lead time necessary for new innovations has shortened. Both of these factors put increased pressure on the innovator of a new product in order to maintain the original advantage over follower firms.

One of the more important issues faced by major manufacturers is how the standardised international product will be sourced globally. Kotabe and Omura refer to sourcing strategy as "...identifying which production units will serve which particular markets and how components will be supplied for production." (Kotabe and Omura, 1988, p. 113).

Vernon's international product life cycle model (1966, 1974, 1979), describes how the various sources of inputs into the product and the characteristics of the product determine the best strategic location for manufacture at a particular stage of the product life cycle. Kotabe and Omura feel that the current generation of MBA graduates can easily overcome the model and out-maneuver it as an aggressive competitor. They point out that the model does not recognise the multinational firm as having "...simultaneous goals of establishing a global sourcing system, serving multiple global markets, and proactively driving the manufacturing and marketing experience curves." (Kotabe and Omura, 1988, p. 115).

Kotabe and Omura have developed a local sourcing strategy encompassing four fundamental decisions related to sourcing strategies:

(1) location of the production facilities,

(2) the particular phase of production necessary,
(3) components sourcing either internally or externally, and
(4) assembly of the components either internally or externally.

Decisions one and two are important exogenous factors having an indirect effect upon the component supplier's decision to attempt to source to a particular major manufacturer. Decisions three and four have a direct effect upon the component supplier from the implications of which way the decision is made by the major manufacturer. Their study found that forty-one percent of the multinational firms frequently use a mix of sourcing strategies simultaneously, and that there was no significant difference observed between marketers of consumer versus industrial durable products.

Several sourcing points were established in the study by Kotabe and Omura:

(1) assembly locations are generally major component sourcing locations also,

(2) Japanese firms are more likely to source components from their own country,

(3) components can be sourced from various locations, thus giving some validity to the global sourcing observation. (Observing the necessity of standardisation of components and the product.)

Lowe and Crawford (1983) find growing evidence that new technology may lead to better opportunities for smaller firms for two reasons:

(1) The new technologies themselves may reduce the minimum size necessary for efficient operation by shortening production runs or more rapid machine changeovers; and/or

(2) Entry barriers to various industries are reduced as existing processes are made obsolete.

Lowe and Crawford list sources of new products as in-house R & D, joint ventures with other companies, research associations, or technology licensing.

Burt (1989a) argues that in technology intensive products, like aerospace and electronics, suppliers must master new components and be capable of designing new components. This assessment agrees with Smith's (1990) view that new alliances, long-term, are built between the major assembler and the component suppliers to meet the new competitive threats faced in the civil aerospace industry. These alliance place more responsibility upon the component suppliers to perform functions as described in Burt's article.

Many smaller firms are able to invent new products or technologies, but may lack the financial and technical resources to take them through the field trials, safety testing, and the innovation and commercial development stages necessary to reach the market. This paradox presents an interesting opportunity for collaboration with larger manufacturers, particularly through technology licensing, which allows a firm to capitalise on its R & D property by realising cash flows from a more rapid exploitation of the market by the larger organisation.

7.3.2 Purchasing-marketing (buyers'-sellers') interface

Leenders et. al., argue that the supplier selection decision is the most important aspect in supply management. They state that this decision must be a team decision based on available key resources and requiring closer communications within the organization and with suppliers. The authors feel that purchaser-supplier relationships are measurable "...For a long-term supplier of major needs the assessment will be based on past and current performance, personal relationships with a number of personnel in both organizations, and even future expectations."[24]

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24. Leenders, Fearon & England, 'Purchasing and Materials Management', Irwin: Boston; p. 247.

Porter considers it rare that a seller group faces a homogeneous buyer group. (Porter, 1980, Chapter 6). The characteristics of the buyers have much in common amongst each other as well as with the sellers, there are a limited number of buyers, competition is usually keen, and the product quality and serviceability must meet exceptionally high standards. This comparison carries through to the buyer-seller interface between the major assemblers (buyers) and the SME component suppliers. This interaction is further discussed using several examples below:

JIT Purchasing Methodology

Because of the changing environment towards JIT purchasing methodology, different relationships are developing between the buyer-supplier. Oliver and Wilkinson (1988) found the most widely used element of supplier relationships was the buying out of non-core activities. They also found in their research the use of quality assured and JIT supply practices. According to the authors, the problems commonly encountered with British suppliers were JIT delivery, not with quality assurance. They did find, however, that many of the companies encountering these delivery problems admitting much of the blame was due to their own purchasing departments. Apparently the purchasing function is lagging the manufacturing methodology and administrative information systems being implemented.

Jarillo (1988) raises a defensible point that major manufacturers should use subcontractors and outside suppliers, even in a complex situation, to maintain flexibility and be able to trim operations and react to new opportunities or downturns. This observation coincides with these research findings which include the perception amongst the SMEs that they are the expendable portion of the long range strategies of the major manufacturers.

Dion, Banting and Hasey (1990) studied firms involved in marketing to JIT purchasers, with over sixty percent of their output to such purchasers. The authors found that:

(1) fifty percent of the firms perceived JIT prices were lower;

(2) sixty percent perceived significantly higher quality of product delivered to JIT buyers;

(3) seventy-five percent reported handling costs were not higher under JIT delivery contracts; and

(4) the majority of respondents did not report higher profits under JIT contracts, which is inconsistent with (1) and (3) above.

The authors explain several of their research findings are inconsistent, because of other factors involved, with current understanding about JIT advantages. For example, the current perception is that JIT pricing is higher than non-JIT products. Dion et. al. explain their finding of lower pricing because of other incentives driving down the price of the JIT products: longer-term contracts, exclusive supplier, other business with the same firm. The inconsistency of JIT quality not-increasing prices is partially explained by greater production efficiencies through modification of the plant, better materials or training of personnel. Their article focuses on the importance of longer-term relationships, close communications, sharing of technical and administrative information and modification of the purchasing methodology. (See also Puto, et. al. 1985; Stamm & Golnar, 1991; and O'Neal, 1989).

Stamm and Golnar (1991) find in their research of small JIT manufacturing firms that stability of production schedules is hampered by erratic demand for their product. They found significant correlations existing between customer and supplier linkages in decreasing lead times, shipment sizes, finished goods inventories and number of deliveries after implementing JIT manufacturing techniques. They also found that JIT

manufacturing and delivery methods did not increase prices, in agreement with Dion et. al. above.

Burt, while discussing the concept of single sourcing, believes that quality may dramatically improve when using single sourcing because the supplier is able to focus and feel a commitment to the component being manufactured. He also argues that buying solely on cheapest price is not necessarily the least expensive in the long-term because of hidden costs; e.g. production line downtime, rework, scrap, warranty work, legal fees, etc. which affect quality and therefore quality assurance costs. Stamm and Golnar's research supports this increased quality from single sourcing concept also.

Evans and MacKenzie (1988) approach controlling bought-out costs from the perspective of managing the suppliers' costs, which is compatible to Burt's theory above. They discuss essentially the same hidden costs as Burt does, but approach the problem differently by advocating prevention of quality problems and alternatives to JIT purchasing procedures.

Giunipero (1990) investigates motivating and monitoring JIT supplier performance as a guide to quality. The respondents to his research indicated quantitative rating systems were used by forty-three percent as a positive motivator; fourteen percent believed that on-going communications was the key; and supplier performance reviews were used by ten percent. "A third group felt that the creation of a long-term business relationship was a strong motivating tool. This group stressed coordination, cooperation, trust and loyalty."[25] The author also emphasizes the priority for lead-time management, which provides proper design, tooling, requisitioning, and set-up times, and allows integration of the order into other production runs.

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25. Larry C. Giunipero, 'Motivating and Monitoring JIT Supplier Performance', Journal of Purchasing and Materials Management, Summer, 1990, pp. 19-24.

Thompson (1990) proposes a vendor profile analysis technique for prepurchase evaluation of vendors. He advocates the prequalification of vendors as a critical activity for quality assurance and ultimate customer satisfaction. His model uses a weighted point method employing key dimensions evaluating alternative vendors and multiplying by expected performance ratings. The summated score is then used in vendor selection.

Limited Sourcing

Beamish and Munro's (1987) research concludes that small firms that serve a manageable number of customers (implies limited number) in carefully selected market segments are more successful. Although this research finding at first seems incongruous with the often-stated goal of market diversification or broadening of base, it is in fact compatible with the desired closer relationships associated with JIT manufacturing systems and purchasing objectives.

O'Neal (1989) describes the relational aspect of JIT purchasing and marketing, emphasizing an industrial buyer-seller exchange relationship. O'Neal uses the term 'relationship marketing' to emphasize the longer-term, close relationships needed for JIT manufacturing and purchasing. Puto recommends that newer firms trying to break into the market should be willing to take a smaller portion of an order to gain recognition and reputation. (See also Smith, 1990).

Bradley (1985) believes that marketing is the 'conceptualisation of a philosophy', (paraphrased), which correlates with the awareness of the purchasing needs of the customer. (Agrees with Porter, 1980). Although his article deals with the supplier's point of view towards their customer, it is also applicable for the buyer's attitude towards their supplier. Both Burt (1989a) and Bourantas (1989), in separate articles, stress the importance of establishing and improving closer relationships with suppliers. Woodside,

Sheth & Bennett (1977) emphasize the importance of individual and organizational goals and characteristics in the industrial buying environment. They believe that the buying decision relies heavily on personal choice, even in a professional corporate buying atmosphere.

Global Sourcing Effects

Kotabe and Omura (1989) researched the global sourcing strategies of global manufacturers. Their sourcing typology deals with a four-country framework, involving: home country, a foreign market country, a developed third-party country and a developing third-party country. They found that standardization of the components and the product supports global sourcing.

7.3.3 Customers

The SME component suppliers must look beyond their immediate customer, the major manufacturer, to the ultimate consumer.

Giunipero (1990) found in his research that quality measurement dealt with the following measures: (Paraphrased from article)

(1) customer returns and rejects, both in monetary amounts and frequency;
(2) late or missed shipments because of quality;
(3) average quality of products being shipped;
(4) number of 'no-charge' slips issued to customers; and
(5) warranty calls.

Beamish and Munro (1987) comment that successful small firms emphasise customer service in their marketing programme. Paul Thackray (1990) concurs with this argument, stating that customer service and quality are the real issues for management attention.

Before entering into a long-term supplier relationship, O'Neal advocates care in customer selection for the supplying firm. The effects of JIT upon supplier/customer relationships, more careful selection of a major

manufacturer or other customer was given emphasis by forty-one percent of his respondents. O'Neal's research is applicable to the component suppliers because their changing relationships with the major assembler must be based on long-term considerations for maximising results and development of partnership-like relationships. His arguments also recognize that the sub-contractor must be realistic and provide to the ultimate customer product warranties and service.

In a study by Kaynak and Stevenson (1984) of the measurement of company strengths and weaknesses, product and marketing orientation appears to have more importance than management determinants. Their Canadian study rates quality of products, pricing of products and understanding customer needs and requirements as having a more positive effect on propensity to export than overall quality of management.

8.0 CHAPTER CONCLUSION

Western businesses are making significant changes in their operating methodologies and procedural relationships with suppliers, customers and even competitors in reaction to competitive pressures. This literature review looked at six aspects of these changes. First, the traditional and modern economic theories were discussed to determine if they could adequately explain the changing symbiotic relationships, which is the subject of this research. Once it was determined that they do not directly answer this question, the natural science term of symbiosis was explored to modify it as a business understanding technique.

To better understand why changes are taking place, the various factors acting upon modern industry were explored - Japanization of Western business, physiological dependency factors, globalization

implications, global competition, global environment, and international activity. Another important player in the change process are the governments of the major assembler, component suppliers, and their customers. Governmental activities explored included multi-faceted governmental influences, historical perspective, general government functions, and distinctive governmental influences. The next section searched for how the participants are meeting the challenge through strategic planning and implementation of change. This included an understanding of Porter's 'Five Competitive Forces', strategic planning, and internationalisation activities.

The last section explores change itself, and its various implications. This includes planned change, procedural changes (e.g., manufacturing changes, quality changes, purchasing changes, administrative support systems, and financial changes.), and changing relationships (e.g., influence of large manufacturers upon their component suppliers, purchasing-marketing (buyers'-sellers') interface, and customers.

CHAPTER THREE INDEX - **RESEARCH METHODOLOGY**

CHAPTER THREE - RESEARCH METHODOLOGY

1.0 INTRODUCTION

1.1 Introduction

This chapter explains which methodologies were utilised to research the selected topic of this dissertation. The selection is dependent upon the complexities of the subject studied (changing relationships within the civil aerospace industry), the depth of previous research about this subject (limited and indirect), and the intent of this research (to further knowledge about the increasing symbiotic changing relationships between a major assembler and its component suppliers). (Zikmund, 1983)

1.1.1 Research intent

The research intent of this dissertation is to examine the extent and manner in which major high-technology manufacturers are developing closer ties with their component suppliers. These changing relationships will be studied using a different approach from the traditional economic analyses by using a modified version of the natural science phenomenon of symbiosis.

1.1.2 Type of study selected - exploratory

"An exploratory study is undertaken when we do not know much about the situation at hand, or when we have no information on how similar problems or research issues have been solved in the past. ...Exploratory studies are thus important for obtaining a good grasp of the phenomena of interest and for advancing knowledge through good theory building."[26] (See Sproull, 1988; Zikmund, 1983; also Riley, 1963.)

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26. Sekaran, 1992, p. 95.

When a new approach or study method is being used, the researcher is uncertain as to what results, opportunities or difficulties will be encountered. The use of an exploratory study allows flexibility to the researcher to develop research methodologies and procedures to 'custom fit' the facts and circumstances. Sekaran labels this flexibility as informal preliminary information gathering to determine what steps are necessary to research the subject.

The literature search did not uncover previous scholarly studies on the changing relationships between major high-technology manufacturers and their key component suppliers, not least in the civil aerospace industry. Because of this lack of previous empirical research it was deemed desirable to have as much flexibility in the research design as possible. It was therefore considered that an exploratory study would best meet the requirements of this dissertation.

1.1.3 Definition of empirical research

To achieve the research intent formulated above, a fundamental review of business research methodologies and empirical research techniques is made.

Empirical research is defined as research based on observation and experiment, not on theory. (Riley, 1963, Tullock, 1966, Sproull, 1988). For this dissertation's purpose, it is defined as research provable or verifiable by experience (business research and experiential knowledge) and field observations, made in the form of questionnaires, visual inspections and triangulation techniques.[27]

The inclusion of business research in the definition of empirical research contributes to changing relationships by acknowledging that

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27. Webster's Encyclopedic Unabridged Dictionary of the English Language. 1989, Portland House, New York.

experiential knowledge assists the user to make informed choices. Business research may be defined as "...the systematic and objective process of gathering, recording and analyzing data for aid in making business decisions."[28] It is therefore concluded that business research techniques assist the empirical research objectives as related to the role of symbiosis in the changing relationships between the entities involved.

1.2 Defining Research Objectives

The research focus of this dissertation is to examine the nature and extent of the changing interaction between a major manufacturer/assembler and a sample of U.K. based component suppliers. Further, the natural science concept of symbiosis is tested as a method to describe and analyze the possible relationships involved.

The five elements of this research necessary to draw a conclusion has already been established in chapter one, they are:

- What, if any, changes have been made by the major assembler in key areas of their operations? (Lead-in question, figure one.)

- Have the changes outlined above been observed by the sample of SME component suppliers? (Level one, figure one.)

- Have the SME component suppliers, if they observed changes at the major, made mirror-image or similar changes in their own procedures and operations? (Level two, figure one.)

- Do the SME component suppliers, who have responded to the major's changes with their own changes, perceive influence from the major on their own decisions to alter their working practices and procedures? (Level three, figure one.)

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28. Zikmund, 1983, p. 5.

- Are the observed changes by the major and the SMEs perceived as mutually beneficial and commensal? (Level four, figure one.)

- What conclusions can be drawn about the changing nature of the relationship between the buyers and suppliers in this study? Furthermore, can the changing relationship between the parties be described as symbiotic as defined earlier?

2.0 RESEARCH DESIGN

2.1 Underlying Factors Leading to this Study

2.1.1 Changing strategic environment faced by modern businesses

Western manufacturers are experiencing significant threats from competitive pressures from Japanese and other new entrants, and increasing governmental, customer and shareholder demands. This in turn has led to the development and uses of new materials and technology, especially electronics and composite materials, and changes in manufacturing, quality assurance, and purchasing methodologies. Reacting to these challenges, Western firms are striving to regain their manufacturing preeminence through the implementation of improvements in their operations and procedures.

The increasing implementation by Western manufacturers of strategies to meet these threats and opportunities are affecting the traditional business relationships between major prime manufacturers and their myriad subcontractors and suppliers. The changing nature of these new relationships raises in turn the question of how the subcontractors react, if at all, to the requirements of their major manufacturing customers.

2.1.2 Increasing mutual dependency

There is academic and anecdotal evidence suggesting that the changing relationships are leading to greater mutual dependency between the prime manufacturer and their suppliers. This increasing interaction has been explained and analyzed in terms of economic analysis (e.g., transaction analysis, traditional economic theories, etc.) and by the so-called 'Japanization of Western Management' theories and practices. (This theory is set out in chapter two.) However, these methods do not address the phenomenon of the relationships changing between the two entities from the perspective of the mutual methodological changes being undertaken in reaction to the strategic pressures placed upon the players.

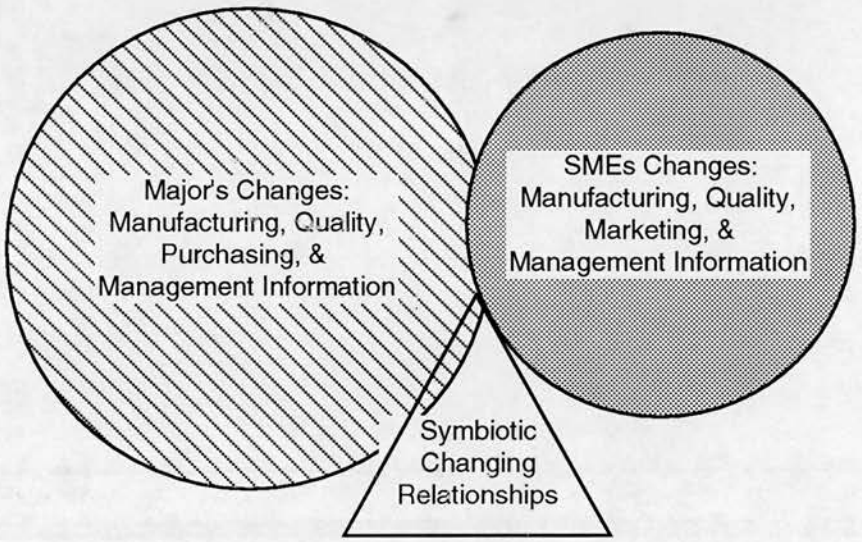
This dissertation addresses the relationship issue from an alternative manner, drawing on the natural science phenomenon of symbiosis. Symbiosis, together with the related concepts of commensality and mutual beneficiality, is used to study the phenomenon of growing interdependence discussed above. At its simplest, symbiosis can be seen as the advantage to be gained by both parties, as in the example of the Gleaner fish which lives near the mouth of the shark. The smaller fish feeds on the parasites in the shark's mouth; the shark therefore benefits from the natural hygiene service provided, and in return allows the small fish to feed and survive. The shark provides protection and indirectly, the food for the smaller fish. It is in the interest of neither party that the powerful shark swallows its smaller service provider. Both participants receive mutual benefits from their association together, and a commensal relationship is formed.

The natural science explanation of symbiotic change, as modified to the business environment, is illustrated below. The natural science term is modified to indicate the changing beneficial and commensal relationships between the larger, more powerful major assembler and its myriad of SME

component suppliers. Because of changing economic forces acting upon them, both parties are undergoing various changes as previously defined.

The research methodology chosen must attempt to verify if the changes being made are a result of mutual beneficiality, if perceived or actual influence exists, and if a commensal relationship has developed.

Figure One - Symbiotic Changing Relationships



2.1.3 Symbiotic changing relationships defined

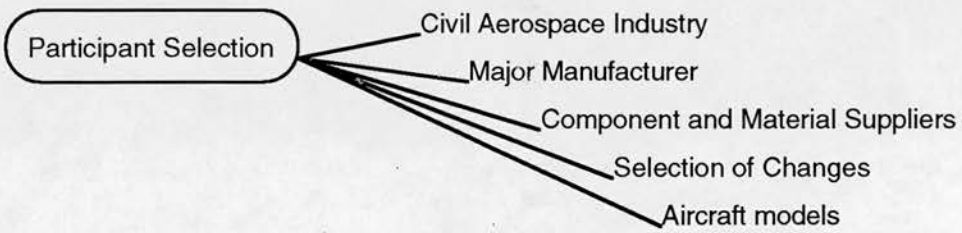
A symbiotic changing relationship is redefined, for purposes of this dissertation, as occurring when two entities are each undergoing specific changes in their manufacturing, purchasing or administrative support systems, and their business relationships are changing concurrently. This changing relationship often includes a commensal association between the two business entities. Further, it is likely that both entities receive mutual benefits from the changes undertaken.

The definition is further extended to include the concept of mutual changes, either similar or mirror-images of each other, by the two different sized entities involved.

2.2 Selection of Sampling Framework

The rationale for selecting the civil aerospace industry, BAe, the Prestwick division of BAe, and the various SME component suppliers of Prestwick is illustrated below in figure two.

Figure Two - Selection of Sampling Framework



2.2.1 Definition of sample universe

To test the relevance and the academic viability of the symbiotic concept, it was felt that the study of a high-technology industry, for example aerospace, automotive, or electronics, would be appropriate. This is because such industries are experiencing major changes in their strategic environment. For example, the rapidity of technological development or the threat of new entrants from Asia often require major strategic improvements. High technology industries normally have a limited number of major firms acting as designers, financiers, assemblers and marketers, while drawing on a large number of subcontractors for components and services. (See Tullock, 1966, and Sproull, 1988, for further discussion about setting the subject and method of inquiry for a sample population; and Riley, 1963 about designing the research process within the sample universe.)

2.2.2 Sampling unit

With the factors described above in mind, the aerospace industry was selected for this dissertation as it meets the criteria established. There were also commonsense and practical advantages in selecting the civil

aerospace industry - the researcher comes from Seattle, the home of Boeing, which assists in making a future longitudinal study feasible. Further, Britain currently retains a vibrant indigenous aerospace industry, which is less true for the electronics and automotive industries.

The aerospace industry is perceived to be globally oriented, has transitory and demanding customers, utilises high-technology and requires quality assurance, out-sources an appreciable percentage of components and sub-assemblies, and consists of a limited number of major manufacturers, each of who are easily identifiable.

The aerospace industry itself can be divided into civil aircraft, aero-engines, military aircraft and weapons systems. Each of these segments operates in somewhat varying environments and has different exogenous factors influencing them.

Because of this industry segment complexity, it was deemed desirable to limit the study to one segment, civil aerospace, for this dissertation. Civil aerospace was chosen because it is noted for its innovation, technology and proclivity for change. A listing of civil aerospace salient features are:

- reputation for using high technology materials and components;
- global sphere of operations;
- limited number of major manufacturers who are easily identifiable;
- sources from a large variety of component and material suppliers from a geographical dispersed base;
- uses tiers of suppliers, e.g., component suppliers, who use sub-assembly suppliers, and material suppliers, etc.; and it is
- known for extremely high quality assurance requirements that are demanded by its customers (the commercial airlines) and government safety regulations.

Each of these factors suggests the likelihood of continual change in such areas as managerial, manufacturing, and purchasing methods and procedures. This possibility of continual change enhances the likelihood of finding changing relationships between the suppliers to the industry and the major assembler.

Another reason for selecting the civil aerospace industry is that it appeared not to have been heavily studied by social science or business researchers; therefore favourable responses to interview requests were more likely. This assumption proved correct; in actuality the U.K. component supplier owners and managing directors were very responsive to this research.

Editorial note: Several respondents commented that this was the first time they had been approached by a university researcher; they found this surprising. The respondents further commented that they felt a responsibility to the community and universities, and would welcome (within reason) contacts in the future.

2.2.3 Choice of sampling framework

Within the civil aerospace industry there were several alternative sampling frameworks which could be used. For example, a study of all, or at least an appropriate sample of firms in the civil aerospace industry; a study of a segment of such firms, such as limiting to European based firms only; or a study of one major firm (a case study) together with its component suppliers. Although each of these sample frameworks has non-exclusive advantages and disadvantages, the exploratory nature of the study as discussed earlier favours a case study approach.[29] (See Sproull, 1988, for discussion about case studies.)

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29. The arbitrary assignment into segments is not unique to social sciences. Tullock, 1966, page 167, states ..."Every branch of science deals with some special class of

2.2.4 Case study - major manufacturer

A case study is an intensive investigation of one firm over a significant period. An advantage of the case study is obtaining additional information about a single, or limited number of, respondents. If the research is properly conducted, information gathered can be very detailed, rich and explanatory. This method is likely to remit analysis of the interactions among the limited number of participants, and the various relationship nuances involved. The in-depth case study should help to achieve a well-rounded feeling of familiarity with the operations of the company studied, as well as with the personnel involved. (Riley, 1963; Sproull, 1988.)

The disadvantages of a case study are at least two-fold. First, it is difficult to justify to the firm's management the amount of time asked of the respondent for conducting the research. A second disadvantage is that a sample of one cannot give practical quantitative, or even qualitative, data leading to a detection of trends or results representing probabilities for the general population. To test properly an implicit hypothesis, multiple observations are arguably required, indicating a potential weakness of the single case study approach.

The writer concluded by selecting the single case study approach for the major manufacturer, favouring the advantages over the disadvantages. It was felt that the case study, while in no sense generalized to other industries, or even to other firms within the civil aerospace industry, best met the requirements of this exploratory study. As mentioned earlier, longitudinal studies can be performed in the future to test the applicability of these results to other firms or industries.

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phenomena; that is how we divide the general field of human knowledge into branches. In each case the special phenomena under investigation present special problems which are met with nowhere else."

2.2.5 Multiple case study - SME component suppliers

The appropriate method considered for gathering data from the SME component suppliers to the major assembler was the multiple case study. This method uses a predetermined number of respondents and queries them in depth, although not to the extent of a single case study. (Riley, 1963; Sproull, 1988.)

The primary advantages of this method include:

- an acceptable-sized data base,
- ability to study a broader cross-section of firms than is true with a single case study,
- spontaneous comments by a variety of respondents,
- possible detection of trends or other forms of analyses.

The disadvantage of this method is the relative shortness of time allocated to each respondent. This disadvantage however, as will be discussed under the methodology of data collection used, was overcome by the choice of interview techniques. This in practice allowed the interviewer to encourage the respondents to give much greater time then they had originally intended.

2.3 Selection of the Major Manufacturer for the Case Study - BAe

Once the civil aerospace industry segment was selected, a request was made to the major indigenous civil aerospace manufacturer in Britain - British Aerospace (Commercial Aircraft), for assistance in this research.

The Commercial Aircraft Division of BAe responded favourably by suggesting their Prestwick Airlines Division as a suitable research site. The Prestwick facility is a complete aircraft assembler, (e.g., Jetstream 31 and 41 models), and was in the process of undergoing changes in managerial and production methods. Prestwick is an autonomous operation with complete

staff and line responsibility (except for the centralised sales office located at Commercial Aircraft Division headquarters in Hatfield, England). Because Prestwick is a complete 'miniature' aerospace company, it is often used as a test site for new managerial, production or purchasing systems and procedures by BAe, Plc. This unexpected bonus increases the likelihood of the researcher to observe any changes in the relationships between the manufacturer and its component and material suppliers.

Prestwick manufactures two aircraft models - the Jetstream 31 and 41. These are twin-engine propeller aircraft normally seating nineteen and twenty-nine passengers respectively. They are considered very durable and economical aircraft to operate and are in operation worldwide. The Jetstream 41 is going into production the first half of 1992 and is being used as the impetus for implementing the various changes discussed throughout this dissertation.

2.4 Selection of Component Suppliers - SMEs

British Aerospace - Prestwick cooperated fully with the research objectives of this dissertation. As part of this cooperation, Prestwick allowed reasonable access to its list of approved component and material suppliers.

As will be explained, more than fifty percent of the suppliers on the list were engineering machine shops. The sampling choice aim was to obtain a cross section of types of components or material suppliers, as well as geographical diversity. This was designed to minimize impacts of regional economic conditions and industry-specific factors on data gathered. To control research costs and to avoid cultural differences upon the data gathered, the decision was made to remain within Britain for all companies selected. In addition, an upper limitation was placed on the size of component suppliers sampled, which is explained below.

A 'disproportionate stratification' sampling of thirty-seven companies was chosen from the list of two-hundred fifty firms supplied by Prestwick. In practice, the firms selected are more representative of a cross section of the suppliers then their numbers originally suggest. A profile of the participating SME firms by type of principal activity are illustrated in table one below.

Table One - Profile of Multiple-Case Study Participants

Type of firm	# firms
Specific parts or component manufacturing	10
General engineering and precision turning firms	9
Interiors, seats, windows	3
Jigs, tooling and dies	3
Coatings, heat treatment	3
Molded plastic and rubber components	2
Forgings and castings	2
Wire and specialty steel products	1
Sheet metal forming and bending	1
Total	34

'Disproportionate stratification' is the process of dividing the component suppliers into distinct groups, or strata, and selecting disproportionately separate samples from each group. (Hoinville et. al., 1987.) Pure random sampling techniques were not used because many of the suppliers come from the engineering (machine shop) industry; a more representative sample across all supportive industries was desired. Therefore non-probability sampling techniques were used. Non-probability sampling is defined as where personal judgment of the researcher is used as the basis for participant selection. (Zikmund, 1983, Chapter 3.)

A geographical dispersion within Britain was deemed necessary to minimize influences or impacts from local economic, political, or social conditions affecting the research findings. Jean Morton-Williams believes

that, "In general, the sample for qualitative work must be broadly enough based to allow for comparisons not foreseen as important at the planning stage."[30] This procedure was easily implemented, as the SMEs are well dispersed throughout Britain because of their crossover work in other industries and wartime dispersion policies. Very few of the firms are clustered around major aerospace locations. In addition, the major aerospace locations are reasonably well dispersed because of wartime passive defence planning policies.

Size of the component and material suppliers interviewed is limited to either less than four hundred employees or less than £25 million annual turnover. This limitation generally follows the British and American guidelines for small and medium-sized businesses (SMEs). The major reason for this size limitation is the arguable conclusion that, in a smaller company, operational change may be easier to detect, and if found, easier to trace the source of the influence that lead to improvements. Smaller firms are perceived to be entrepreneurial in nature, and perhaps more subject to change than their larger counter-parts. (Not verified in this study.)

2.5 Identification and Selection of Issues to be Studied

Once Prestwick was selected, top management was contacted to arrange for intensive interviews with selected managerial personnel (more than four and one-half days). After the interviews at Prestwick were underway, it became apparent that three major operational areas of change were appropriate for this study - manufacturing/quality, procurement and administrative support.

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30. Hoinville et. al., 1987, p. 17.

These change areas encompassed the heart of the strategy which Prestwick's management was attempting to revise:

2.5.1 Manufacturing/quality assurance changes

Prestwick has implemented, and is continuing to implement, significant changes in JIT production methods, cellular manufacturing techniques, and total quality management.

2.5.2 Procurement changes

Prestwick is implementing changes in their procurement methods to single or limited sourcing, supplier design and contract management, longer-term contracts, and development of a feeling of partnership amongst their component suppliers. JIT delivery schedules for parts and components are being implemented coinciding with the other changes.

2.5.3 Administrative support systems

Administrative support changes include Prestwick's payment procedures, vendor contributions to development costs, contract administration, electronic tie-in of informational data bases and internal accounting procedures.

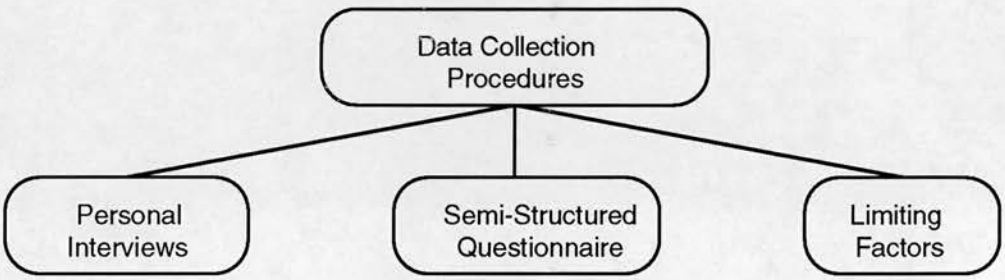
The initial implementation of these Prestwick reforms had begun within the three years before the interviews, and were not necessarily all completed or in place. Some aspects of management's desired changes were being implemented in conjunction with the introduction of the Jetstream 41 model, and did not have a long 'track-record' as of the interview dates.

3.0 DATA COLLECTION PROCEDURES

The data collection procedure used in this research was a semi-structured questionnaire administered by one researcher through personal

interviews at the respondents' location. (Discussed in Zikmund, 1983, Hoinville, 1987, Sproull, 1988.) The three factors involved in this procedure are illustrated in figure three:

Figure Three - Data Collection Procedures



3.1 Personal Interviews vs. Postal Questionnaires

3.1.1 Personal interviews

The primary advantages of a personal interview while gathering research data are the ability to clarify questions that the respondent may not understand, the desired information is complex, and to probe when there appears to be more information available. (Hoinville, 1987; Sproull, 1988.) Other pertinent advantages of personal interviews included:

- ability to triangulate information from respondents through personal observations and discussions with respondents' colleagues;

- personal relationships with respondents which may result in plant tours;

- informal discussions;

- mutual exchanges of additional information;

- an extremely high response rate, (only three firms declined to participate out of thirty-seven queried); and

- significant data and spontaneous information can be gathered in a relatively short time.

The personal interview procedures used by the researcher varied slightly between the major manufacturer and the component suppliers.

Major manufacturer

The researcher made an initial appointment with the operations manager (second highest level of authority at Prestwick) for a day of briefings and orientation to Prestwick's operations. The operations manager then scheduled meetings over several days with various managers in areas that were deemed appropriate for research - manufacturing, purchasing, quality assurance, production control, etc. Individual appointments were then scheduled with each of these managers. Several walk-throughs of Prestwick's facility were offered and utilised. The researcher was allowed to talk freely with production personnel during the walk-throughs or during lunch in the consolidated dining hall.

Formal semi-structured questionnaires were administered through personal interviews for each area of responsibility. Follow-up questions or additional information was provided through telephone calls or mailings.

SME Interviews

For the SMEs, appointments were made in advance with the owner, managing director, or their designate. The sole criterion asked of the respondent was that they be familiar with production, purchasing and management information systems and procedures within the firm. In the medium-sized as opposed to the smaller firms, several personnel were normally interviewed, each with a speciality in the above-mentioned areas. If the interviewees did not know the answer to a question, they were encouraged to ask a knowledgeable person working in that area. All unanswered questions were cleared (i.e., someone knowledgeable asked for an answer) before the researcher left the company, so that each questionnaire was as complete as possible.

All appointments were scheduled far enough apart (maximum of two per day) to allow for flexibility in timing. Upon completion of the interview, plant tours were accepted when offered, additional conversations were encouraged, and a genuine attempt was made to leave as a 'friend of the firm', who would be welcome to return in the future.

The interview usually started with a verification of student status and a gaining of trust to dispel possible suspicions of industrial spying. This often was accomplished by explaining the researcher's previous business background as well as why a dissertation was being undertaken at this time. The purpose and method of research were explained briefly to satisfy the respondent of confidentiality of information, reinforcing the explanations given in a letter mailed previously. That letter also verified the appointment time and date and other administrative matters.

The tempo of asking questions varied according to individual response rates, but the contents of the actual questions were uniformly asked. An attempt was made to give standard explanations to all respondents who asked for additional information. In addition, every attempt was made to avoid leading the respondent to an answer or to a desired conclusion.

Notes were made during the interview and used at the end to encourage spontaneous comments or to ask further open-ended questions. For example, the managing director might mention that he had spent several years in the automotive industry. Queries were then made at the end of the interview concerning differences observed between the automotive and aerospace industries, and what areas are common to the two industries. These comments occasionally indicated specific changes taking place within the aerospace industry that could either triangulate a previous answer, or provide opportunities for additional discussions.

An example involving an executive experienced in two industries is a spontaneous conversation comparing the paperwork between the automotive and aerospace industries. Further queries led to the managing director's observation that British Aerospace's paperwork-handling is still cumbersome and inefficient, and his perception that it is used occasionally to delay payments on invoices. The managing director then contrasted BAe's paperwork procedures with those of the German aerospace firm, MBB, which he perceived as more efficient and realistic. He favourably compared MBB with Japanese automotive firms located in Britain such as Toyota or Nisson. These comments verified (triangulated) his previous answers to structured questions observing attempts to change the payment procedures by BAe. He also commented that the attempts are not uniformly successful, nor noticeably at the same degree of change, amongst the various operating sites throughout BAe.

Minor problem encountered

A minor problem expected, and encountered, in the research was getting past the secretarial staff to the managing director. The impression was given that numerous unsolicited telephone sales calls are attempted to managing directors; an effective secretarial screening buffer was therefore created to safeguard management time. One of the three companies choosing not to participate was an example of not getting past the executive secretary. The secretary 'allegedly' relayed messages between the managing director and the researcher, but she may have used her own 'discretion' in denying the request for an interview. The engineering company was not deemed critical to the research as it duplicated several other companies already interviewed; therefore alternative methods of making contact were not attempted.

3.1.2 Postal questionnaire - considered, but not used

An alternative method for collecting data is a postal questionnaire. The major advantage of this method is it permits a very broad coverage, in theory at least, of the sample population. (Hoinville, 1987; Sproull, 1988; Sekaran, 1992.)

Large-scale mailing of questionnaires, when properly controlled and conducted, can be an effective method of data-gathering. The advantage of this method is that large amounts of information can be gathered, often at a reasonable cost in time and decreased travel expenses to the researcher. This information is useful for building a statistical data base and for detecting trends amongst the defined population. Replication of the research is often easier to administer than with other methods, and longitudinal studies are arguably easier to implement using this method.

The large data base can be an effective analytical tool useful for purposes even beyond the original research objectives. Examples of this usefulness include: governmental planning purposes, comparisons with other published research findings, and publishing articles on related subjects.

Postal questionnaires provide an opportunity for the respondents to structure their answers more properly and to reflect on their responses to the questions. This opportunity might arguably produce more thoughtful responses than other methods.

The disadvantages of this method are its current over-use and its intrinsic impersonal nature. Many companies receive regularly mail questionnaires, some from dubious sources that may not be ethical research inquiries; therefore they may become resistant to responding. Current empirical research literature using postal questionnaires as data gathering methods are reporting response rates of fifteen percent or less. This low

response rate creates a dilemma for the researcher attempting to interpret the limited information received, a possible lack of statistical validity, and correct interpretations of the non-responses.

A second major disadvantage of postal questionnaires is that spontaneous information and open-ended questions are difficult to obtain because personal contact is missing. Because of this lack of personal contact, spontaneous information is often omitted from the completed questionnaire. When personal contact exists, additional questions may be explored and important spontaneous information may be obtained by the researcher. In addition, the respondent may wish to add indirect information relevant to the subject matter, but not directly requested in the questionnaire. This indirect information could be invaluable in understanding the total operating environment of the respondent and adding a richness to the material gathered.

To conclude, for purposes of this dissertation, it is argued that face-to-face interviews result in better observations as well as generate spontaneous respondent information, which may be withheld using other methods described above.

A second advantage of personal interviews is that, because this is an exploratory study, the richness and depth of responses and the subtle nuances in answers given are considered as important as the data gathered.

Because of the above stated advantages, and the researcher's decision to use a case study approach, the personal interview method rather than the mass-postal questionnaire was selected.

3.2 Semi-structured Questionnaire vs. Structured Questionnaire

A semi-structured questionnaire was used for personal interviews with both Prestwick and the component suppliers. The structured portion of the questionnaire provided uniformity of questions asked during the data gathering and provided a data base for statistical-analysis purposes. The semi-structured portions of the questionnaire allowed for spontaneous or gratuitous information-gathering and use of probing questions, thus taking advantage of informal information offered throughout the interview process. (Hoinville, 1987; Sproull, 1988; Sekaran, 1992.)

A more formal structured questionnaire was not utilised because of the exploratory study being conducted. It was deemed important to gather as much information as possible from all respondents, not just a standard check-list of information. A formal questionnaire not asking for opinions, perceptions and even perspectives does not enrich the information gathering process. (Tullock, 1966; Hoinville, 1987.)

At an early stage before any interviews at either Prestwick or SMEs, the SME questionnaire was pre-tested on nine component suppliers in the electronics industry. Adjustments were then made to solicit information better or to eliminate leading questions. A visit was made to Prestwick to discuss with the operations manager the primary functional areas in which top management saw themselves implementing major improvements. This visit helped to clarify the major issues to be studied in the detailed interviews to be held at Prestwick. These interviews in turn permitted the writer to adapt his original SME supplier questionnaire from the electronic industry. This new questionnaire was subsequently tested for its appropriateness, completeness and understandability with one of Prestwick's suppliers. In the light of this test, minor adjustments were made to the final semi-structured questionnaire administered to the thirty-four firms chosen.

A complete component supplier questionnaire is attached as Appendix A. In summary, it consists of four sections:

1. General overview section querying the component supplier company and its operating strategies. This section searches for general change and observations of management as to change in factors outside the company.

2. Manufacturing - searches for significant changes in production and purchasing methods or procedures within the previous three years, and if found, to query for symbiosis to or from the Prestwick Civil Airlines Division of BAe.

3. Marketing - (antithesis of purchasing by Prestwick) searches for marketing strategy changes and comparison of Prestwick's buyers to others. Questions mirrored the purchasing questions asked of the major manufacturer.

4. Management Information - searches for management information system changes or policy changes. These changes can be indicators of other changes in production, purchasing and marketing; or as indicators of symbiosis.

Each section also included questions designed to encourage spontaneous discussion or open-ended responses. At the end of the questionnaire, the respondents were asked if there were any other subjects that they desired to discuss, or if they were expecting to answer a question that wasn't asked. This additional procedure often generated spontaneous discussions about a wide variety of business subjects and information offered. This information added a richness to the research information gathered that would not have been possible using a structured questionnaire format.

3.3 Limiting Factors

Three important factors affect the choice of research techniques, placing natural limits upon the research design and methodology used in this dissertation. These limiting factors include the diversity of the aerospace industry, overall operating spectrum of component suppliers, and the apparent non-existence of a comparative previous study. Other lesser factors that must be considered include the limitations of the case study approach, time constraints, geographical considerations and the personal interview technique. All of these limiting these factors are further discussed below.

3.3.1 Diversity of the civil aerospace industry

A limiting factor is the diversity of the aerospace industry itself. The aerospace industry includes civil and military aircraft, aero-engines, avionics, spacecraft, as well as service and support activities. Many of the component suppliers operate in several of these environments. Careful attention was necessary to question the supplier only about the civil aircraft portion of the industry. In several instances, the component supplier operated at different levels within the civil aircraft market, e.g., supplying sub-assemblies to one division and complete components to another division of British Aerospace. This supplier might also have been serving Airbus and or U.S. firms such as Boeing or McDonnell-Douglas. Care was therefore necessary to focus on the chosen major manufacturer - the Prestwick Airlines Division of British Aerospace. The methodological answer was partly answered by addressing specific questions using a Likert scale to measure their perceptions.

3.3.2 Operating spectrum of component suppliers

The component suppliers to the aerospace industry cover a wide spectrum of divergent industries and types of ownership. The various

suppliers interviewed operated in the following industries: engineering, surface coatings, electronics, hydraulics, metal forging, metal turning, metal treatments, windows, interiors, antenna's, plastics and rubber moldings; amongst others. In addition, many of these component suppliers operate in several industries simultaneously. For example, some interviewees were simultaneously operating in automotive, electronic and aerospace industries at varied intensities, as well as in another primary industry.

Types of ownership amongst the respondents include smaller subsidiaries of larger, often international, corporations, publicly-held listed corporations, and closely-owned limited companies. Twenty-nine percent of the respondents were closely held companies, the remaining seventy-one percent were subsidiaries of larger corporations or Plcs themselves.

Because of this diversity, the component supplier questionnaire had to allow for industry variance and possible idiosyncrasies, yet maintain a consistent underlying search for change. For this reason, a semi-structured interview technique was chosen to insure uniformity of questions posed, and concurrently, flexibility to allow for industry differences. The interview technique had to provide for spontaneity of information as, or if, volunteered by the respondents. (Hoinville et. al., 1987.)

This spontaneity frequently discloses the variety or spectrum of businesses and industries served which is otherwise not apparent. For example, a valve manufacturer mentioned, during a facility walk-through, that aircraft valves had much in common (except for size) with valves that they were producing for the oil drilling and exploration industry. These valves had many common quality standards and were used under harsh working conditions. The work for the oil industry had not been discussed during the interview, but added an interesting dimension to the interview of the interaction between two diverse industries.

3.3.3 Lack of comparative previous study

The current literature search did not find an existing scholarly study specifically about the changing relationships between the major assembler and their component suppliers within the aerospace industry. Furthermore, a study has not been found that included the natural science concept of symbiosis as the means used to explain changing relationships between participants in a mutually beneficial, commensal relationship. These limiting factors were turned into a benefit, indicating the need for a study to answer these topics as research objectives. The result provides the original contribution to knowledge that is a necessary element of a dissertation.

3.3.4 Other lesser limiting factors

Case study limitations - The reader should be aware that whenever a single case study approach is utilised the findings should not be generalized into the sample universe. The conclusions drawn from a limited sample are applicable to the subjects studied, and must be used with caution when making inferences to a broader application. The other material limitation of the case study method is its cost to administer and amount of time consumed.

Limits of time constraints - multiple case studies and personal interviews are limited to the amount of time that busy executives can allow for interruptions of their schedules. The researcher must balance fact-finding with not becoming intrusive or obstructive to the workplace, and thus creating ill-will amongst the participants. All of these factors are a limitation that must be recognized.

Limits of geographical considerations - restricting the field interviews to one nation may skew the results by national political bias or heritage considerations. This national tendency must be considered when applying the results to other cultures or nations.

Limits of personal interviews - an argument can be made that whenever personal opinions and observations are asked for, there is an inherent danger of responses that make the interviewee appear best. This argument of self-praise is accepted, and properly accounted for in this research. The methods used to counter this tendency was to ask progressive questions which would tend to highlight inconsistencies given earlier, personal observations of the interviewer during the visitation, and triangulation of the responses by third parties familiar with the interviewee's company. In addition, many of the types of questions asked were not of the type leading to self-gratification, but were about the respondents observations of the civil aerospace industry or of Prestwick. Overall, the researcher was satisfied that the impact of this human tendency was held to a minimum and does not significantly influence the results of this research.

4.0 CHAPTER CONCLUSION

The specific research objective of this dissertation was to determine the existence, extent and nature of the changing symbiotic relationships between an aerospace major manufacturer and its small and medium-sized component suppliers. The decision was made to limit the research to a segment of one industry, civil aerospace. Contact was then established with the major civil aerospace assembler in Britain, British Aerospace Plc. (BAe) BAe in turn recommended that their civil airlines division in Prestwick be utilised for this research as it is a complete assembler and currently undergoing significant changes. Prestwick furnished their component supplier list for selection of thirty-four SMEs to test for symbiotic changing relationships between them and Prestwick.

The combination case-study method was selected as most appropriate for this research dissertation. In turn it was felt a case study focused on one major manufacturer, together with a multiple-case study of a sample of its component suppliers, would vigorously test the research objectives. The personal interview technique was used, implemented by using semi-structured questionnaires during interviews at both Prestwick and their component suppliers. In addition, open-ended and opinion-seeking questions were used to encourage not only spontaneity but also further discussions.

The obvious caveat to all empirical research is that it is not an exact science and cannot be a precise measurement of either Prestwick's operations or of the component suppliers' attitudes, values and business judgments. "In varying degrees, surveys underestimate the complexity of human behaviour and attitudes; they can generally paint only a sketchy picture of society since their results are subject to errors of commission and omission."[31]

This research, however, does provide a systematic measurement that aggregates data from a representative sample of component suppliers serving one major manufacturer. This measurement, if carefully interpreted, can be useful and meaningful in exploring the symbiotic changing relationships between a major manufacturer and its component suppliers.

In the next chapter, we will examine in some detail the nature of the aerospace industry and the changing pressures and issues that are influencing the strategies of the major players. This review will help to set the firms chosen for the case study within their broad industrial context, and how their changes may be viewed from the symbiotic changing relationship.

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31. Hoinville, et.al., 1987, p. 182.

CHAPTER FOUR INDEX - **THE CIVIL AEROSPACE INDUSTRY**

CHAPTER FOUR: **THE CIVIL AEROSPACE INDUSTRY**

1.0 INTRODUCTION

> "Science and technology in our time have come to play the role that war and exploration formerly played in expanding a nation's economic resources.[32]

1.1 Chapter Orientation

This chapter addresses the current operating environments of the civil aerospace industry and the factors from it which influence symbiotic change. A general review of the civil aerospace industry is applicable to both the major manufacturer and the smaller component suppliers in analysing the symbiotic relationships interacting between the two entities.

Because of the potential symbiotic factors involving change within the aerospace industry, the content of this chapter is a major influence on the choice of methodology discussed in Chapter Three. Similarly, the review of the appropriate literature in Chapter Two assists the reader's familiarisation and understanding of the industry in the context of its total environment. Finally, this chapter presents the underlying operating factors and history in preparation for the chapters concerning the major manufacturer and the component suppliers.

The civil aerospace industry was selected for this dissertation because it is noted for its innovation, technology and proclivity for change. A summary of the industry's salient features appropriate for this research are:

- a reputation for using high technology materials and modern manufacturing procedures;

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32. Leonard S. Silk in Simonson, 1968, p. 258.

- a global sphere of operations, procurement, service and marketing;
- a limited number of major manufacturers who are easily identifiable;
- it sources from a large variety of component and material suppliers from a geographically dispersed base;
- it uses layers of suppliers, e.g., component suppliers, who use sub-assembly suppliers, who use material suppliers, etc. (supplier chain or layers); and
- it is known for extremely high quality assurance requirements which are demanded by its customers (the commercial airlines) and government mandated safety regulations.

1.2 Symbiotic Changing Relationships

In order to test the relevance and the academic viability of the symbiotic changing relationships concept, it was felt that the study of a high-technology industry, for example aerospace, automotive, or electronics, would be appropriate. This is because such industries are experiencing major changes in their strategic environment. They are also industries in which a limited number of major firms act as designers, financiers, assemblers and marketeers while drawing on a large number of subcontractors for components. With this factor in mind, the aerospace industry was selected as it is perceived to be globally oriented, have transitory customers, demands high-technology and quality assurance, has an appreciable percentage of out-sourcing, and consists of a limited number of major manufacturers, each of whom are easily identifiable.

The aerospace industry itself can be divided into civil aircraft, aero-engines, military aircraft, and aerospace segments. Because of this

complexity it was deemed necessary to select one segment to research for this dissertation. Civil aerospace was chosen as the appropriate industry segment for the study of changing symbiotic relationships.

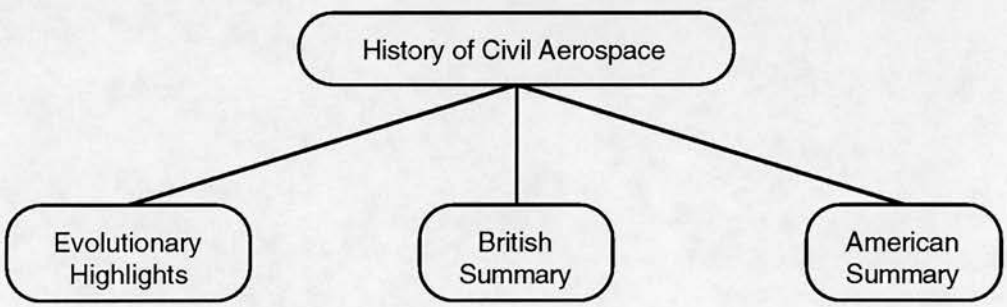
1.3 Summary of this chapter:

This chapter is divided into four segments. The first segment is a general history of civil aerospace, separate from the military viewpoint. The second segment describes the major players in the civil aerospace market, which is in a state of flux due to the political events in Eastern Europe. The third segment discusses what the players do in the civil aerospace industry. The fourth segment discusses the changing strategies and business forces acting upon the participants within the civil aerospace industry.

2.0 HISTORICAL HIGHLIGHTS OF CIVIL AEROSPACE

The history of civil aerospace is discussed from three perspectives: evolutionary highlights, the British summary, and the American summary:

Diagram One - Historical Perspectives of Civil Aerospace



2.1 Evolutionary Highlights

The development of aviation from the first manned powered flight in 1903 to the present is familiar to most readers and will not be retold here. The evolutionary highlights of civil aviation, however, are important to the

understanding of emergence of a proper civil aviation industry separate from its military counterpart. This separation of civil from military aerospace is paradoxically dependent upon various phases of government intervention and or participation, which implies a military (defence) motive. This underlying motive must be examined from the historical perspective of civil aviation and governmental interactions of various types in order to understand more fully the consequences and nuances of changing symbiotic relationships between Prestwick and its suppliers.

The original aircraft industry was devoted almost exclusively to military aircraft. Civilian aviators usually flew converted aircraft left over from World War I. These flying machines were often not reliable, had few people comforts, and were costly to maintain. The military aeroplanes redeeming value was that they were plentiful and relatively inexpensive. Until the mid-1920's the biplane was generally favoured over the monoplane, and wood & canvas were the common construction materials, slowly being replaced by metal. Late in the 1920's, the technique of stretching metal over airframes and the design of the reasonably sized in-line liquid-cooled aero-engine began to make civil aviation feasible.

The Douglas DC-3, introduced in 1935 with air conditioning, autopilot, and noise reduction, was the first truly passenger oriented commercial aircraft to reach the market in mass numbers. An article in Flight International described the technically advanced airliner as:

> "...It had a robust structure of newly developed high-tensile aluminum alloy for long life and ease of maintenance; a fatigue-resistant multi-spar wing with split flaps ...enabling the wing loading to be increased and resulting in a more efficient structure; two reliable supercharged air-cooled engines...; variable-pitch, feathering, three blade, metal propellers with governors to keep them

running at a constant, preset speed; and a retractable undercarriage with toe-operated hydraulic wheel brakes."[33]

World War II witnessed the ultimate development of the piston engine, made long distance four-engined aircraft practical, introduced jet aircraft and initiated development of the helicopter. (Further development of helicopters awaited needs of the mountainous Korean Conflict and initially was little utilised by civil aviation.) The Korean Conflict demonstrated the versatility and reliability of helicopters, and helped usher in their eventual acceptance by civilian users.

Development of the Douglas DC-4, the DC-7, and the Lockheed Constellation set the standard for four-engine long-distance commercial aviation following WWII. Jetliners appeared early in 1949, starting with the DeHavilland Comet, and closely followed in the 1950's by the Boeing 707 and Douglas DC-8. Jetliners, characterised by catholic designs meeting various needs of the world's airlines, have continued to dominate civil aviation.

Recent technology has concentrated on fuel and operating efficiency, engine noise, weight reduction and composite materials. (Todd & Simpson, 1986). Environmental concerns about noise abatement and engine exhaust pollutants became industry mandates in the 1980's.

Aircraft landing rights and people-capacity concerns at airports, with available gates becoming extremely political, are currently the biggest strategic planning problems of the civil aviation customers, the commercial airlines. Both the industry and its customers are struggling with decreasing passenger miles and cutbacks of corporate travel promulgated by the Gulf War of 1991 and the impact of world recession.

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33. Flight International, 3 July 1976, p.23.

2.2 British Summary

Commercial aviation had a long and characteristically cyclical gestation period following World War I. The first airlines used converted bombers; fares were inordinately higher than other forms of transportation. The inadequate equipment was not designed for passenger comfort, economy of operations or low maintenance costs. The airlines virtually disappeared by 1921, re-emerging later in the decade with American commercial models designed specifically for passenger service.

World War Two agreements with the United States had Britain taking the lead in development of short range fighter aircraft and the U.S. with long range bombers. This agreement had the disastrous result of British industry emerging from the war with little expertise in long-range heavy transport aircraft. The Princess flying boat was an early attempt to overcome this deficiency. This design was not commercially feasible, with ten Proteus prop-jet engines and some designs even having a swimming pool aboard. The Barbazon was a luxuriously appointed fifty passenger airliner that did not fly until 1949; it was considered impractical by the world's airlines because of high operating and maintenance costs per passenger mile.

The DeHavilland Comet series of commercial jet aircraft gave new impetus to the British aircraft industry, derived from the early lead Britain had on jet engine development. The Comet eclipsed the jet civil market by several years, ahead of its rivals from Boeing and Douglas. Unfortunately, a fatal blow to the British long range aircraft development programme occurred with several fatal crashes of the Comet jetliners in the early 1950's due to metal fatigue, with the loss of all aboard.

Reed (1973) argues that one of the problems faced by Britain's manufacturers after the war was that successive governments were incompetent concerning the aircraft industry. Each change in controlling

political party meant that they had to relearn the peculiarities of the industry, thus causing many interruptions and lags in development and production. Some governments even cancelled vital research or development programmes as part of their cost-cutting policies. The nationalisation of the industry during the seventies created disincentives for efficiency because of excessive tiers of management, according to Reed. In some aspects, the industry is still struggling to eliminate excessive management tiers today.

Duncan Sandys issued his Defence White Paper in April 1957, which amongst other things, would have eliminated manned airplanes by replacing them with missiles. The effect of the White paper on both the aerospace industry and the Royal Air Force (R.A.F.) was devastating. Sandys main findings were:

- Defence was spending ten percent of the GNP; seven percent of the population were either in the armed forces or supporting them; one-eighth of the metals were used for defence; and a disproportionate number of scientists and engineers were engaged in military projects.

- Development was to be stopped on the Avro 730 advanced strategic bomber, but would be continued on the ground-to-air missile system.

This serious set-back was followed in 1964 by Lord Plowden's committee investigating, 'from their desks' according to Reed, the British aerospace industry and finding that it was an industry in difficulty. The report was received with a total lack of enthusiasm by the industry, which objected to proposals that anything technical should be bought from the Americans and that the airframe industry should be nationalised. The report found that:

- The level of support which aerospace had been receiving was too high, and required reduction. Manufacturers were relying

upon governmental support for enormous front-end costs associated with development of new models.

- The aim of government policy should be to create conditions in which the aircraft industry could thrive with no more support or protection than that given to comparable British industries. This reflected a simplistic approach, which ignored front-end costs and lack of alternative sources of financing available for high-risk civil developmental projects.

- Decisions on mergers of the aircraft companies should realistically reflect the interests of economy and commercial efficiency. At that period of time, 'bigger was usually considered better' and mandated mergers would create, or at least enhance, operating efficiencies.

- Government was becoming too deeply involved in the industry's affairs:

  i. it was the source of most of the industry's finance;

  ii. it made crucial decisions on projects, while management had to deal with the industrial consequences of these decisions; and

  iii. it imposed financial and technical controls using non-qualified bureaucrats, who duplicated the industry's management tiers on almost a one-to-one basis, thus hampering efficiency. The questionable duplication of personnel, often non-business liberal arts graduates from prestigious Oxbridge universities, was particularly resented by the aircraft industry.

After realising sizable losses on the VC-10 jetliner project prior to the 1960's, Vickers chose to divest itself of direct involvement in the aircraft industry and merged its interests with those of English Electric and eventually with British Aircraft Corporation (BAC). Over seventy percent of

the industry was nationalised in the 1970's. Merger of BAC, Hawker-Sidderly Aviation and Dynamics, and Scottish Aviation into British Aerospace Corporation (BAe) was justified by the Labour government as necessary because of its overwhelming reliance upon the public purse. The belief was that state control would:

> "...provide greater public accountability and, by dint of fresh management, lead to a restructuring of the industry along more effective lines, and incidentally, centralise the firms' chaotic missiles divisions."[34]

Government cutbacks in the early 1970's deeply affected the newly nationalised corporations; as explained by Todd & Simpson:

> "It is not without irony that BAC, the product of government machinations, should have virtually foundered in the succeeding decade as a result of government-project cancellations (TSR-2, PT428 missile and OR351 next-generation combat aircraft)."[35]

British aerospace manufacturers have a more consistent track record in collaboration with European counterparts than their political mentors. Collaborative projects that can be classified as technical (but not necessarily commercial) successes are: Concorde (Anglo-French); Anglo-French helicopters; Anglo-French Jaguar strike-trainer; Airbus (Anglo, French, German, Spanish); and, Multi-role combat aircraft (Anglo, German, Italian).

Cost savings in collaborations are often negligible or non-existent. Considering the extensive R&D costs that one country can afford individually, however, collaboration is often the only feasible alternative. Hidden costs of international collaboration include communications, loss of technological leadership, private air fleets by firms necessary to conduct

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34. Todd & Simpson, 1986, p. 191.
35. Todd & Simpson, 1986, p. 157.

business, languages, translations and immense travel burdens on the executives involved.

Space is an area where British industry has not successfully linked up with European partners. The ill-fated European Launcher Development Organisation was established to use the British Blue Streak rocket as the first stage, but the French second stage and German third stage never functioned properly; therefore Britain eventually withdrew from launchers, preferring to concentrate on satellites.

The future of the British civil aerospace industry inevitably lies in international co-operation over a wide field, avoiding the expensive duplication which has sapped the energy of the world's aviation industry during recent years. Civil aerospace, by its very nature, is an international business. The routes and products of this business cross political frontiers constantly, which mandates international co-operation.

Between twenty-five and thirty-three percent of Britain's entire aerospace exports are component parts and sub-systems; this allows Britain to enjoy a level of aerospace infrastructure not available to other European nations. (Todd & Simpson, 1986). U.K. aerospace exports were £7.8 billion in 1989, with a positive trade balance of £3.2 billion. Ron Howard, president of the Society of British Aerospace Companies, commented:

> "If British manufacturing could perform as well as its aerospace sector, the country's balance of payments would soon be in the black rather than £20 billion in the red."[36]

Current employment is approximately 200,000; 1989's annual turnover was £11.4 billion; these facts make British aerospace the third

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36. Ron Howard, Machinery and Production Engineering, 6 July 1990, p. 56.

largest aerospace business in the world. In addition, aero-engines sales increased to £2.96 billion in the same year.

2.3 American Summary

The American aeroplane industry remained very small until World War One; only 49 aircraft were built in the United States during 1914. The ability to expand capacity is illustrated by the fact that by 1918 the hastily mobilised industry was producing 14,020 aircraft per year.

The period between the world wars was characterised by cyclical conditions of prosperity or complete dependence on limited military contracts. In the United States, the depressed post WWI economy led to several governmental acts that ensured a civil aircraft industry:

- The Air Mail Act of 1925 authorised the Postmaster General to contract for airmail services, which in essence established regularly scheduled flights between cities.
- The Air Commerce Act of 1926 gave the Secretary of Commerce responsibility for fostering air commerce through establishment of airports, civil airways and navigational aids, as well as registration of aircraft and certification of flying personnel.

By 1929 civil aircraft sales were $71 million; after the general collapse of the economy during the depression, sales fell to $26 million by 1933. Holding companies were formed by the manufacturers and airlines to gain monopoly powers both in production and air transport. Highly-sought military contracts were controversially awarded to a limited number of companies, selected by procurement officers of the military services to insure continued existence of designated manufacturers necessary for

national defence purposes.[37] The profitable airmail routes were also awarded selectively by the Postmaster General in a similar political fashion, again using national interests as the governing doctrine.

The U.S. government was finally forced to take action due to increasing scandals and public pressure, resulting in the Air Mail Act of 1934. This Act of Congress forced aircraft manufacturers to divestiture their air transport companies. On February 9, 1934 the Postmaster General canceled the domestic airmail carriers' contracts, to be effective in ten days, with the mail to be carried by the Army. This action illustrates the continuing involvement, either directly, or indirectly, with the influence of government and the military on civil aviation during its formative years.

Deteriorating international relations in the later 1930's created growth in aircraft industry exports, giving it a wide industrial base for U.S. entry into the war. The conversion to wartime production was accommodated because many of the firms allowed their technology to be licensed or subcontracted to non-aircraft manufacturers or to smaller Tier II aircraft firms. This sharing of technology and tooling insured rapid expansion of mass production capabilities.

The wartime production plans for engines, handled in three basic patterns, were typical for the aerospace industry as a whole:

(1) Allison was allowed to expand its facilities and draw men from other General Motors divisions as needed.

(2) Wright preferred to handle all final assembly and increased its subcontracting of parts and components.

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37. The practice of awarding selective military and/or R&D contracts, continued until the 1970's, has been critisised as indirectly subsidising American and British manufacturers by their governments. Competitors, such as Airbus Industries, use this argument when countering accusations by Boeing or McDonnell-Douglas that they are competing unfairly because of their governments offering special purchase loans or direct subsidies.

(3) Pratt & Whitney offered to license its products to auto engine and other manufacturers.

Editorial note: the method used by Wright is frequently found in civil aerospace manufacturing today. For example, Prestwick prefers to increase its subcontractor base during periods of increasing volume to avoid down-sizing problems during periods of lesser activities.

The airframe manufacturers used subcontracting more extensively than the engine manufacturers, thus foreshadowing today's preferred procedures of widespread subcontracting and use of suppliers. The government constructed many 'shadow' plants during the war, which were strategically dispersed throughout the nation. These shadow plants were owned by the government, but operated by the airframe manufacturers.

> "In summary, many of the changes in engine and airframe manufacturing processes between 1940 and 1944 could be classed as differences in kind, not just differences in degree. While techniques were borrowed from other industries, the special characteristics of airframes and engines made it impossible to adopt the established techniques of any other industry without revisions. To meet wartime production goals, the manufacturers of airframes and engines were not just forced to do, on a vastly greater scale, a job that they had already been doing in peacetime. They had to do an essentially different job which neither they nor others had ever done before."[38]

The essential lessons that could be learned from wartime production and cooperation techniques include:

- There is no substitute for time in the research and development of a new plane - the best record from go-ahead to the one

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38. Simonson, 1968, p. 139.

thousandth unit was 19 months; the median for one or two engine aircraft was 31 months; and four engine aircraft was 33 months.

- Quantity production is essential for effective air power; this may require government ownership of 'shadow plants' dispersed strategically throughout the countryside.

- Far greater expenditures of time and money are required for development of a new design than for original research.

After World War Two the technologically advanced aircraft industry turned part of its excess capacity into light manufacture. Some of the products utilised the accumulated stockpiles of aluminium to make prefabricated houses, unit construction of schools and hospitals, roof trusses, baking tins, pie-making machines, refrigerators, filing cabinets, milk cans, carpet sweepers, lamp posts, windows and garage doors, and other consumer goods.

Five years after cessation of World War II the aircraft industry was again faced with rapid expansion and having to accelerate aircraft production for the Korean Conflict. This time the industry was hesitant to expand plant capacity because of the expected short duration of the conflict. The manufacturers also faced additional problems:

- Many WWII facilities were inadequate for the larger airframes of new bombers and transports; construction of new facilities was often necessary.

- Airframe companies had to finance this expansion themselves because the U.S. government was hesitant to add more facilities to its large inventory of obsolete space. 'No bricks or mortar' was the byword of the U.S. Defence Department. This departmental policy forced the prime contractors to choose either expansion of their facilities, or, to do more subcontracting than in previous wars.

After the Korean Conflict, the aircraft industry was in a period of transition from dependence upon military defence spending to commercial civilian aircraft production. Although civilian aircraft sales were expanded, the larger market for aircraft was military, which maintained government involvement.

Ironically, subsequent changes in government procurement policies after the early 1950's and their effects were more pronounced than wartime production demands on the aircraft industry. Military procurers considered guided missiles a superior substitute to manned military aircraft, missiles ultimately involved twenty-five percent of the total aerospace industry sales by 1958. The space programme procurement has an even more recent effect on the industry's technological innovation, namely accelerating obsolescence of current technology and materials:

> "...The 'creation' of a new and superior product may form the basis for growth and success of the business involved in its production and sale, while at the same time 'destroying' in part or totally those businesses whose products have been surpassed."[39]

Silk's (Simonson, 1968) strongest feeling about the impact of the space programme on the aircraft industry is the recognition of the interaction amongst many industries necessary for future success.

> "...It is this great impetus which the space programs will give to scientific and technological advance in many fields - in electronics, metals, fuels, the life sciences, ceramics, machinery, plastics, instruments, textiles, thermals, cryogenics, and, most important, to basic research in all the sciences - that provides the reason one must consider the space effort not simply as an elaborate form of modern

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39. Simonson, 1968, p. 228.

pyramid-building or pump-priming but, far more importantly, as a powerful on-going force for innovation and economic growth."[40]

The American airframe industry during the mid-1970's and 1980's was essentially characterised by 'Boeing against Europe', with a watchful eye on the Japanese industry's progress. The European Airbus, available in 1974, began with a very slow sales record, with eighteen finished, but unsold aircraft outside the Toulouse factory in 1978. Airbus Industrie recruited high level executives from the Americans, including sales director George Warde, who proceeded to sell the Airbus to the American airlines and third world countries. Results were that sales exceeded 300 by 1979 and in excess of 1,000 by 1983. This marketing effort is a serious threat to Boeing, which is reacting by considering more joint-ventures with both European and Japanese partners.

The U.S. aerospace industry sales for 1989 were approximately $137 billion, up fourteen percent from the previous year. Defence sales dropped to forty-five percent of the 1989 total annual turnover, heralding the emergence of the civil sector of the industry. 1989 was the first year that civil sales were dominant over military aircraft sales.

2.4 Section Summary

This historical perspective of the civil aerospace industry in Britain and the U.S.A. highlights the emergence of the industry, and its continual dependence upon governmental policies. The late 1980's was the turning point for direct dependence upon various types of governmental assistance programmes. The 1990's is becoming known for the lack of interference by governments, with exceptions by France and Germany in the Airbus programme. These areas will be further discussed below.

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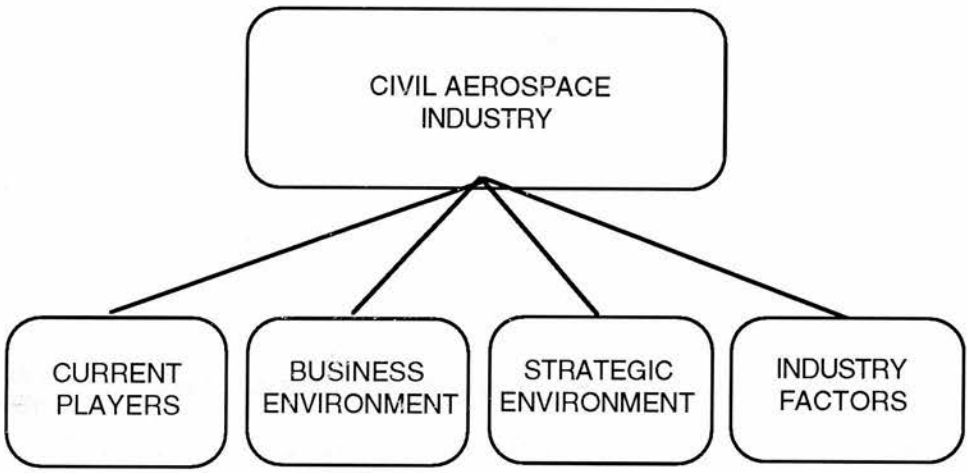
40. Simonson, 1968, p. 258.

The following sections defines who the major players are in civil aerospace, the business environment faced by these players, the strategic environments chosen by management, and industry factors influencing symbiotic change within civil aerospace. Each of these operating factors have a profound effect upon the participants directly and indirectly through their customer, the civil airlines.

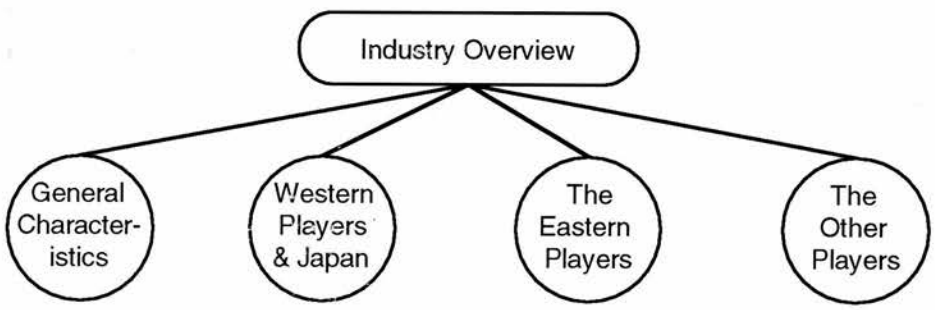
Diagram Two - Factors Concerning Civil Aerospace



3.0 CURRENT PLAYERS IN THE CIVIL AEROSPACE INDUSTRY

This section looks at the general characteristics and the current players in the civil aerospace industry:

Diagram Three - Civil Aerospace Industry Participants



3.1 General Characteristics

Aerospace is one of few industries which combine the maximum usages of, and large re-investments in, the leading edge of science and technology. A recent example is the U.S. Air Force strategic stealth bomber, Northrop's B-2, which proved its technology in the Gulf war. The B-2 has involved the development of more new techniques using advanced composite materials and electronics than any other single aircraft programme. (Financial Times, 29.8.90). Although this is a military example, many of the composites developed for this aircraft are being considered for use in civil aircraft as well, e.g., the Airbus 330 long-range high capacity aircraft.

The multifaceted definition of the aerospace industry encompasses aero-engines, avionics, missiles, space vehicles and the manufacture of both commercial and military aircraft. Because of this breadth of activities, it was deemed necessary to concentrate on the civil sector for this dissertation to keep it in manageable proportions.

> "In the words of Thomas Bacher, Boeing's International Director, civil aerospace is 'one of today's most visible and highly publicised industrial topics'. To him, its technical challenges, the high risks of development and sale and the traditional glamour of flight combine to make it one of the most fascinating business endeavours of our time. Civil aerospace is certainly a hard and often ruthless arena. It is also quite distinctly, an international industry. The market for its products is global, and, increasingly, the development and production of civil aircraft and aero-engines is based on international collaboration. It is not, however, characterised by the operation of multinational companies. The internationalisation of production and distribution in civil aerospace is largely based on nationally-based

firms linked either through licensing, subcontracting, or through full risk-sharing partnerships."[41]

Actual civil aircraft manufacturing constitutes partial-fabrication and partial-assembly operations brought together from global sources to the airframe facility performing final assembly. Civil aircraft 'assembler' is arguably a more appropriate term than 'manufacturer' for the major airframe companies. Boeing, for example, uniformly makes only wings across all aircraft product models; the remainder of the components and materials are either 'bought-in', or manufactured in-house only for specific models.

The industry is considered one of the higher users of components and subassemblies built off-site from the final fabrication facility. This off-site manufacturing involves large numbers of subcontractors and component suppliers. Even large body or wing sections are often assembled long distances from the assembly facility, and then airlifted to the final assembly site, as is the case in Airbus Industrie or Boeing 767 assembly operations. Highly regarded British technology and craftsmanship has consistently resulted in BAe building all of the wings for Airbus Industrie, even when competitive bidding is used. (Todd & Simpson, 1986). The completed wing assemblies are then airlifted to Toulouse for attachment onto the aircraft.

This off-site subcontracting characteristic has given a new lease on life to former major manufacturers, e.g., Lockheed Corporation and MBB. Lockheed, although no longer manufacturing a civil aircraft, builds major body sections and panels for several models of Boeing aircraft, and airfreights them to the Boeing assembly plants. In addition, Lockheed contracts assembly crews to Boeing, directly working at Boeing locations even though they are Lockheed employees. The amount of this work and support for the Tri-Star L1011 is instrumental in keeping Lockheed in the top

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41. Hayward, 1988, p.1.

five civil firms, despite the fact they do not build a complete civil aircraft model of their own.

The emergence of the commercial aircraft industry is an interaction between sensitivity to customer demand (demand-pull) and participation in continuous technical progress (technology-push). The evolution of the industry is rendered possible by this interactive combination of 'technology-push' and 'demand-pull' innovations, defined below.

Technology-push innovations

Technology-push innovations refer to those which influence subsequent industrial complexity or market conditions, which in turn shape the political and economic options through the continual availability of technological products.

An example of a technology-push innovation is the supersonic third-generation aircraft under current design, which will incorporate revolutionary engine design with high-technology composite surface materials. Several new first tier countries, notably Japan, are demanding technology sharing and equal co-partnerships as part of their terms for developmental cost sharing - the political and economic options. The Japanese Ministry of International Trade and Industry (MITI) believes this technology so important to many sectors of Japanese industries that they require (and financially subsidize) the aero-space firms to participate, even though it is not cost effective in the short-term.

Demand-pull innovations

Demand-pull refers to innovations which meet the highly competitive civil requirements of the market, creating further requirements for new technology. The Airbus Industrie programme is an excellent example of sensitivity to the airlines' needs. Airbus' response for wide-body, medium-range, twin-engine aircraft, the A320 and A321 models, eclipsed Boeing or

McDonnell-Douglas' reaction to the market's needs by several years. The Airbus consortium's response to the demand for a complete 'family' of aircraft has led to an entire family of compatible aircraft introducing new technology, e.g., fly-by-wire control systems and full electronic cockpits, common across several of the Airbus models.

The civil aerospace industry is generally considered to operate in three tiers, as described by Todd and Simpson:

(1) Tier I manufacturers are the major airframe and aero-engine assemblers and manufacturers, of which there are relatively few world-wide. The current 'big three' in the airframe sector are Boeing, McDonnell-Douglas and Airbus Industrie (a consortium of independent manufacturers from Britain, France, Germany and Spain; with Dutch, Belgian & Italian associate members). General Electric, Pratt & Whitney and Rolls-Royce are currently the big three in the aero-engine sector.

(2) Tier II firms are the suppliers to the major manufacturers of airframe sections, engine controls, communication and computer systems, gears and transmissions, landing gear, navigational aides and satellites, welding and metal finishing, various components and sub-assemblies, and materials. Tier II firms are characterised by global dispersion and many also serve other industries (e.g., electronics, communications, automotive). This tier is the strata that thirty-four companies were chosen from to research for this dissertation.

(3) Tier III are the service-oriented firms, such as aircraft repair and overhaul, and ground support and consumable supplies firms that often cluster around commercial airports or manufacturers' airfields.

A noticeable change verified from this research is that several of the Tier III firms are now beginning commercial Tier II activities, in addition to their service (Tier III) orientation. For example, a small Tier III firm that

repairs and overhauls passenger windows and seals was interviewed. In addition to this repair function, the firm started manufacturing new windows in 1990 as a Tier II operation. The firm is now manufacturing passenger and crew cockpit windows for the replacement market on existing aircraft, and it is competitively bidding (successfully) to provide window sets for new aircraft builds.

A second noticeable change involves Tier II firms, which are beginning to push for Tier I status. Most noticeable are the West German Group Deutsche Aerospace and the various Japanese aerospace firms. The German group has been successful in securing final assembly responsibility for the Airbus A321 and is now reaching an annual turnover exceeding Deutsche Mark (DM) 15 billion. The Japanese firms are negotiating for co-makership status with any consortiums that they participate in; this status implies technology transfers as well as shared design and build responsibility.

The commercial aircraft industry is truly a global industry. The industry spans advanced technology countries, Eastern-bloc countries and emerging nations with various tiers of assembly, supply or service functions. In many of these countries, aerospace plays a leading role in their economies, their industrialisation strategies and their international balance of payments. The state often deliberately fosters growth of the industry because of its national implications and technological achievements. In several economies the state is an active partner or owner of the manufacturing facilities, e.g., France, Israel, and Brazil. (Todd & Simpson, 1986; Hayward, 1988).

> "There is no magic formula for governments determined to encourage technological innovation to guide either the strategy or the tactics of public policy. Individual fiascoes notwithstanding, the

> symbiotic relationship between the state and high technology is undoubtedly a force of fundamental importance in building the power of nations."[42]

Marketing is global and easily transcends fully-industrialised countries, newly-industrialised countries and emerging nations. Major manufacturers must include in their family of aircraft, models that meet the divergent needs of each of these markets. These models give rise to an opportunity in design and engineering that meets several market needs simultaneously. An excellent example of an aircraft meeting multi-market needs is the BAe 146, a four-engine, regional, quiet, jet airliner. Seat capacity can vary from 70-128, and it is available in commercial freight, executive, or quick conversion night-freighter versions. It is certified to operate over densely populated areas at night, e.g. Los Angeles, New York etc. where noise restrictions ground many other aircraft. It can operate in harsh conditions on short airstrips, so it is attractive to less developed countries, and it has a reputation for economical operations.

Production is global because in reality the major manufacturers are as much assemblers as they are production-oriented. (Close similarity to automotive industry.) Procurement of sub-assemblies and components is world wide. Entire sub-sections may be built in another continent and air-lifted to the assembler. The European Airbus programme and Boeing model 767 are excellent examples of this contracted sub-section concept.

The industry itself is described by Newhouse (1983) as keenly competitive and capital intensive, it employs large numbers of highly skilled personnel and uses advanced, often leading-edge, technologies. Newhouse states the aerospace industry faces enormous financial risks and depends upon a few key airlines that can ensure financial success or failure

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42. Hayward, 1988, p.3.

of a new model. Because of these characteristics, private financing is not attracted to the industry, necessitating large governmental participation or capital risk-sharing among the primary participants in many of the schemes. (See also Reed, 1973).

According to Newhouse, the commercial aircraft industry is very different from its military counterpart. Commercial aviation profitability is planned over a longer production-run, and has enormous front-end development costs which can be recovered, if ever, only after a passage of years. Military aircraft and their development costs are paid for by governments, and the manufacturers' direct costs are protected by cancellation clauses for short-run models.

Other disparate factors which have various impacts on the commercial industry may include wars, missiles and space-age opportunities. Simultaneous cancellation or cessation of several of these factors can stagger even the largest of aerospace companies. Most US aircraft producers reached peak employment during the 1967-69 build-up in Vietnam, and all had suffered sizable cuts by 1970. Particularly hard pressed in 1970 was Boeing, which had reduced its workforce to scarcely one-third of the 1968 high. Boeing blamed the cutbacks on the simultaneous events of a depressed civil aircraft market, failure to get a USAF bomber and a Navy missile contract, and completion of the Saturn booster rocket programme. This Boeing cutback illustrates the dependence upon military contracting during that particular time period. This is contrasted with the current situation after the Gulf War, where BAe and Boeing are having labour force reductions, but not on the scale as in the 1970's.

The aircraft manufacturing industry is tied very closely to its customer, the airline industry. The two industries appear to function in tandem and

share many of the same exogenous problems. "When either of them sneezes, the other catches cold" is a phrase used by Newhouse which aptly describes their close relationship.[43] This relationship is dramatically illustrated by the significant decrease in passenger traffic resulting from the 1991 Gulf war, that is causing numerous cancellations of aircraft orders by many of the world's airlines. For example, British Airlines announced on February 11, 1991 that it is postponing indefinitely replacement of twenty-six aging aircraft; representing orders worth at least £1 billion to the aircraft and aero-engine manufacturers.

Another example of the closeness of the two industries is illustrated by the impact of the financial trouble the airline industry is having. Although order books are at a all-time high, all of the aerospace firms are reducing their staffs because the airlines are delaying delivery or even cancelling orders. The airlines are participating in no-win competitive 'price-wars' in 1991 and 1992 that they cannot afford, with the obvious result that more are declaring bankruptcy. These failed airlines place more used aircraft and cancelled lease aircraft on the market, thus forming another competitor for the manufacturers.

The excess of used aircraft setting unsold creates a booming Tier III industry, companies specializing in storing and maintaining in good condition unused aircraft. Arid locations, such as Arizona and New Mexico with old World War II airfields are preferred sites for these new companies to store literally hundreds of airliners of all sizes and makes until their owners can sell or lease them. More importantly, this glut of used aircraft seemingly has an effect upon the major assemblers, as their order books began

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43. Newhouse, 1983, p. 8.

decreasing after 1990. Both Airbus Industrie and Boeing have announced decreases in production rates of almost all models beginning in 1991.

3.2 The Western Players and Japan

Industry characteristics in the advanced industrialised countries (AICs), which are primarily Western Europe, North America and Japan include:

- employment of large numbers of highly skilled workers, (U.K. employment exceeded 200,000 in 1989),
- utilising numerous smaller component and sub-assembly firms, (8,600 firms in the U.K. in 1989),
- displaying a significant export to total sales ratio, (U.K.'s exports exceeded sixty-five percent of total aerospace sales in 1989),
- a surplus in balance of trade payments, (3.2 Billion £'s in 1989), and
- large investments in research and development programmes (R & D often exceeds twenty-four percent of annual sales), which correlates with the industry record for consistent growth.

A brief description of the major airframe assemblers and aero-engine manufacturers is included below:

3.2.1 Airframe assemblers

The major manufacturers from the advanced industrialised countries comprise the majority of airframe assemblers and aero-engine manufacturers. The twelve largest world-class commercial airframe fabricators and assemblers include: (Percentages represent market share of the group's total 1988 sales.)

(1) The Boeing Aircraft Corporation - 38.8 percent; has highest exports-to-total-sales ratio of the top fifty U.S. exporting

companies in all industries; largest manufacturer of civil aircraft in the world. 1988 sales/employee ratio = $115.

(2) McDonnell-Douglas Corporation - 14.6 percent; major defence contractor with significant civil aircraft presence; product of a 1960's merger between defence contractor McDonnell and civil aviation assembler Douglas. 1988 sales/employee ratio = $124.

(3) Lockheed Corporation - 11.2 percent; although not currently producing civil jet aircraft, their continued support of the 1011 Tri-Star and manufacture of the propeller driven Hercules C130 along with other aeronautical systems still rank them third in the world. Significant fabrication of airframes for Boeing. 1988 sales/employee ratio = $122.

(4) Aerospatiale - 5.3 percent; largest European manufacturer, French, state owned, forty thousand employees; builds airliners, helicopters and missiles, major participant in the Airbus consortium. Formed in 1970 with mergers of Nord Aviation and Sud Aviation. 1988 sales/employee ratio = $158, which was the most efficient of the twelve during 1988.

(5) British Aerospace - 5.1 percent; essentially privatised by 1985; diversified civil and military contractor. Primary civil sites are Prestwick for Jetstream airliners, Woodford for turboprop airliners, Chester for business jets and Airbus wings, and Hatfield for the BAe 146 airliner. It was formed in 1977 by the merger of Hawker-Siddeley with the British Aircraft Corporation. It is a twenty percent stakeholder in Airbus Industrie. 1988 sales/employee ratio = $52. (Increased to £63, approximately $115, for 1989.)

(6) MBB (Messerschmitt-Bolkow-Blohm) - 4.9 percent; employs about one-third of the German aerospace industry, very dependent upon Airbus and other international cooperation programmes. Became part of Deutsche Aerospace Group in 1990. 1988 sales/employee = $101.

(7) Textron Corporation - 3.1 percent; civil helicopters, aerospace technology and systems. 1988 sales/employee ratio = $89.

(8) Fokker - 3.0 percent; Dutch; small airliners; uses sixty percent components from other European companies. Partially state-owned. Strong civil design and development capability. 1988 sales/employee ratio = $88.

(9) CASA - 2.1 percent; Spanish; state-owned; major components and a light transport aircraft in joint venture with Indonesia. Member of Airbus Industrie, with a 4.2 percent stake. 1988 sales/employee ratio = $64.

(10) SAAB-Scania - 2.0 percent; Swedish, turbo-prop aircraft. 1988 sales/employee ratio = $103.

(11) Embraer - 1.5 percent; Brazilian, civil aircraft and components. Has thirty-nine percent of the world's regional airliner market, and is Brazil's sixth largest exporter. 1988 sales/employee ratio = $47.

(12) Shorts of Belfast - 1.1 percent; former nationalised U.K. company, purchased by Bombardier of Canada in the Autumn of 1989. Builds small turboprop transports and major components for Boeing and Fokker. 1988 sales/employee ratio = $47.

The smaller, free-world aircraft manufacturers include: (Listed alphabetically, not by size or market position.)

Aeritalia - Italian; state owned; transport aircraft and components.

Agusta - Italian; state owned; builds Bell helicopters under license, as well as components.

Dassault - French; private 54 percent/state 46 percent ownership; civil business jets (Falcon series), major defence contractor, does sub-contract work for Fokker.

Dornier - German; successful series of utility transports.

PBN (Pilatus-Britten-Norman) - Swiss-owned; built on Isle of Wight, light 'Islander' transport aircraft.

Westland - British; exclusively helicopter production.

Airbus Industrie, when considered as an entity, became the second largest producer of civil aircraft in the 1990's, surpassing McDonnell-Douglas in 1992.

3.2.2 Aero-engine manufacturers

Aero-engines are a major component of commercial aircraft, often costing as much as the completed airframe. Several of the aero-engine manufacturers are as large as many of the major airframe assemblers. Because of these two factors, a brief discussion about the aero-engine manufacturers is included in this section.

The principal aero-engine manufacturers' total sales are about two-thirds of the sales of the twelve largest airframe assemblers. This total sales volume indicates the complexity and costliness of aero-engines. The top four include:

(1) General Electric - 35.4 percent; U.S., private. 1988 sales/employee ratio = $147, which is the most efficient for 1988.

(2) Pratt and Whitney - 34.6 percent; U.S., private. 1988 sales/employee ratio = $96.

(3) Rolls-Royce - 19.6 percent; British, private; largest engine manufacturer in Europe. 1988 sales/employee ratio = $88.

(4) SNECMA - 10.4 percent; French, state-owned. Considerable experience in international cooperation with Bristol-Siddeley and Pratt & Whitney. Long term collaboration with General Electric to build the CF6 engine for the European Airbus. It is the fourth largest civil engine builder in the world. 1988 sales/employee ratio = $97.

The final portion of this section about the Western players concludes with a discussion about one newcomer to the tier 1 market - Japan.

Hayward argues that the broader phenomenon of the 'latecomer' economy, such as Japan's, learning from, and then surpassing established industrial states, is well known. He feels it is significant that Japan has now begun to adopt a leading-edge strategy in the face of competition from newly industrialising states, and one of the chosen areas is civil aerospace, with special emphasis on supersonic transports.

Japan, although presently not having a major Tier I capability, has committed itself through the auspices of the Ministry of International Trade and Industry (MITI) to become a world-class manufacturer in the aircraft industry. Following World War II, its industry was allowed to begin work on military aircraft in the 1950's and was primarily a Tier III operation overhauling U.S. Air Force planes from the Pacific theatre of operations.

Gradually the Japanese began producing both military and civil aircraft under license from U.S. companies as well as components for various U.S. aircraft manufacturers. They are participating in a major role in the new RJ2500 jet engine with Rolls Royce; they also produce several aircraft of their own design. The companies involved in airframe construction are MHI at Nagoya, Kawasaki at Gifu, and Fuji at Utsunomiya; IHI at Tanashi is concentrating on aero-engine production.

> "Japan sees its high-technology industries as the key to future growth and prosperity. Other industries rely on them. They stimulate foreign commerce, the profits from which help to pay enormous energy costs. Also, as it becomes more difficult to compete against South Korea, Singapore, Taiwan and Hong Kong in products at the middle to lower levels of technology, the pressure increases on the Japanese to invest more heavily at the high end. They are impressed by the potential of the jet airliner, first because it blends so many high technologies, and second because it earns so much foreign capital for America. They don't seem to be intimidated by the risks and uncertainties of the airliner business or, indeed, of any business. Any high-technology venture is fair game...."[44]

Japan's current MITI commitment to developing Tier I aerospace capabilities is illustrated by its involvement in the Advanced Tactical Fighter (ATF) programme with the U.S., in a co-producer capacity. This programme is experiencing significant cost overruns and development delays, but MITI insists on continuing the programme because of the advanced technology being transferred. It is possible that this information will be utilised to leap-frog present civil airliner technology to the third generation of aircraft and aero-engines, and thus enable Japanese entry as a realistic competitor in Tier I markets.

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44. Newhouse, 1983, pp. 221-222.

Japan has reaffirmed its commitment to research into supersonic transport (SST) with substantially increased funds authorised for 1989-1996 for research into SST propulsion, heat-resistant materials and airframes. Combined ramjet and conventional turbofan powerplants are proposed for subsonic and supersonic flight fuel efficiency, illustrating MITI's objective of developing a third generation commercial aircraft. (Flight International, 7 October, 1989.)

3.3 The Eastern European Players[45]

Rivalling the United States in total aerospace capacity, the USSR is geared primarily to military production and space technology. Even the state airline, Aeroflot, is commanded by an Air Force General and its airliners are designated reserve military transports.

The fundamental difference between Soviet aerospace and its Western counterparts is that separate bureaus are responsible for design and for production facilities. It is estimated that there are approximately forty Tier I plants dispersed throughout the Soviet Union, but with their policy of secrecy, actual numbers of personnel involved are more difficult to estimate. Each Soviet plant also manufactures civilian consumables, not only to hone the workers skills but also to help ease the financial costs of such a large military burden. It is predicted that the civilian consumables portion will increase as the military production decreases, because of the political events set in operation during 1990.

Originally conceived for national defence purposes and supplying the needs of other Warsaw Pact countries, the Soviet aircraft industry has begun to emphasise exports more heavily. The USSR is increasing its marketing

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45. Data valid through June, 1991. Events are changing rapidly in many of the former Eastern-bloc countries, therefore the reader should refer to current events literature.

efforts to third-world countries for military aircraft. Since 1980, current estimates place exports in excess of forty-one percent for combat aircraft produced, but civilian aircraft are beginning to gain sales, with state-of-the-art technology such as fly-by-wire and full electronic controls being offered.

The Unified Countries from the former USSR are interest in forming alliances with Western aerospace companies. A loose alliance has been formed in March, 1990 to determine the feasibility of developing a new-generation supersonic passenger airplane. The alliance includes the Tupolev Design Bureau, Boeing, Aerospatiale, BAe, and McDonnell Douglas.

The aerospace industries in the previous Warsaw Pact countries until 1990 were virtually Soviet subsidiary companies producing copies of existing Soviet designs. In some instances, they have been allowed to produce specific aircraft types for their internal use and sale to other countries in the Pact. Only the Romanian aircraft industry operated independently of Soviet directives. The state-owned Romanian industry has been quite successful in joint ventures with Britain (airframes and engines) and Yugoslavia (light transports).

The current manufacturing structure is not clear because of the political upheaval during 1990 and 1991; there are indications, however, that some Eastern European countries are attempting to re-establish or develop their aerospace industry. Romania seems to be leading in their desire to establish a major civil aerospace industry. They are successfully building an older BAe model in cooperation with BAe and seeking other sub-contract work.

Although China is independent of Soviet control and directives, its aircraft industry is still partially influenced by Soviet design and production methods. Its aircraft are normally powered with Soviet engines. Since the

late 1970's, China has made technology-transfer agreements with Western companies, with Rolls-Royce as a leader, and has become more independent of Soviet influence. China has not developed a significant Tier II or Tier III network; therefore each industrial complex is integrated vertically to build as many parts as it is technically capable of producing. A modest export phase is underway with China providing simpler machine parts for Boeing 737 and 747 models, and landing gears for the McDonnell Douglas Super 80. China is currently negotiating for a larger percentage of the build programme for the Boeing 767, emphasizing its increased quality controls, as well as hinting at its massive civil market for potential purchase of aircraft. It is not clear to what extent China has negotiated with Airbus Industrie to either build a plane or sub-contract parts or components.

3.4 The Other Players - The Newly Industrialised Countries

Indonesia, Israel, South Africa, Egypt, Taiwan, South Korea and India all have emerging aircraft industries, and Brazil has the eleventh largest major airframe assembly firm Embraer. The various governments look to the aircraft industry both as a means of obtaining military independence from industrialised countries and as sources of generating export sales affecting their international balance of payments.

The usual entry method is to build a light military trainer aircraft, fully subsidised by the government, and then to commence commercial production with a piston or turbo-prop engine light-transport aircraft (which may have military value also). Several of the countries, notably Israel, are using licensing agreements to build sophisticated jet aircraft, usually in the military fighter configuration, that can be used for their own defence but also can be exported to other countries.

Indonesia is unique in that the impetus for establishing an aircraft industry is for civil rather than military purposes; this industry is regarded as an integral part of their national development programme.

Brazil has a very successful aerospace company, Embraer, which was originally state-owned but is now partially publicly-held. It has become the sixth largest exporter in Brazil. Embraer is a complete airframe assembler as well as a component supplier to other global aircraft fabricators. In 1989 it sold 55 model EMB-120 Brasilias, with export revenues totalling $505 million.

Other countries that are establishing aircraft assembly industries include Turkey, Iran, Pakistan, Thailand, the Philippines, Argentina, Chile, and Peru. These industries often have a strong military influence for alleged defence purposes.

4.0 BUSINESS ENVIRONMENT

As explained in the introductory section of this chapter, the major manufacturers are the primarily designers, financiers, assemblers and marketeers within the civil aerospace industry. Each of these important functions will be further discussed below. These functions are similar to the host in a commensal relationship and reinforce symbiotic relationships.

4.1 Designers

The relatively few major civil aerospace manufacturers are responsible for the pre-launch research and design of a new aircraft model. An increasing trend is to involve the airline customers into the initial design of a new model. The Boeing 777 model carried this concept further by including the airlines, tier 3 repair firms, production personnel and the

normal contingent of engineers and designers into the complete cycle of conceptualizing and designing the model.

As previously mentioned, the Boeing 777 composite design team created a computer programme that simulates the human form superimposed into each space drawn for the aircraft. This programme envisages whether there is room for a human of average proportions to build, replace or repair parts or components as the design work progresses. Apparently the engineers were quite surprised about how difficult they had been designing aircraft for the service and even assembly personnel. The airlines members requested, and received, in-flight accessible parts for routine replacement by flight crews, e.g. light bulbs, circuit breakers etc.

The design function has slowly begun to 'trickle-down' to qualified subcontractors. For example, a subcontractor may be responsible for the entire landing gear and related hydraulics systems for a new model. The design specifications will state how much gross weight must be supported, how many landings and take-offs, target assembly weight and other end-user considerations. The subcontractor is given design freedom for type of materials, system design, parts simplification and standardization, and finally, the total build responsibility including subcontracting. The completed major part is tested and then delivered to the major assembler ready for installation.

The design function often creates demands for new materials, composites, procedures or techniques that give the aerospace industry its reputation for innovativeness and constant change. This factor means that, to be successful in the modern competitive environment, both the major assembler and the component suppliers must be receptive to change and accept their responsibility for change. This naturally raises the question

queried in this dissertation about the degree of symbiosis between the two entities in their changing relationships to meet these challenges.

4.2 Financiers

Traditionally the major manufacturer has been responsible for the pre-launch feasibility studies, research and development costs, design costs of the chosen model, and the front-ending of manufacturing costs once production was started. As the entire cost started to become extremely large, $4 billion for the later models, airlines were asked to make financial contributions through deposits on early orders or even through direct contributions.

The natural progression of this cost concept has the major assemblers approaching their component contractors and material suppliers for direct financial contributions, increasing design work, samples, and even spare parts. For example, B. F. Goodrich Tire and Rubber agreed to design and furnish the brakes and tires for the Boeing 767, thus ensuring that they would have the lucrative after sales and service replacement market virtually guaranteed for an estimated forty years. Prestwick approached their major component suppliers and received nearly fifty percent of the launch costs either in cash or in-kind parts or services for the Jetstream 41 model introduction.

The new model pre-launch costs are rising dramatically and governments are declining from financially participating, both of which are forcing new coalitions forming between fierce competitors. For example, in early 1993, Boeing, BAe, and Deutsche Aerospace confirmed that they were studying the feasibility of jointly developing a new, high passenger capacity airliner for the twenty-first century. (A 550 - 800 passenger model with long range capabilities.) The press release estimated the airframe development

costs to be in excess of $12 billion, which virtually eliminates two competing models surviving.[46] A similar problem exists for the design of the aero-engines for this model, with estimated development costs equalling or even exceeding the airframe costs.

Once the aircraft is completed a new financial problem arises - financing the customer. Airlines have consistently lost money from operations since deregulation in 1980's. This not only dries up their cash flows, affecting their ability to buy new aircraft, but also discourages leasing companies or financing companies from participating in the airline segment of the market. The major assemblers have found themselves in an increasing role of participating in the financing of aircraft sales. Boeing and Airbus Industrie have a long-standing feud over financing of large aircraft, subject to the GATT treaty. Boeing accuses Airbus governments, particularly France and Germany, of providing low interest loans or non-competitive leasing agreements for purchases of Airbus aircraft, thus 'unfairly' winning customers for Airbus Industrie.

Prestwick management stated in a December 1992 conversation that the Jetstream 41 continues to sell well, but getting paid at time of delivery is an increasing problem. This business factor is related to one of the less popular changes made by Prestwick extending payments to their suppliers from 120 to 180 days whenever possible. This delayed payment strategy reinforces the concept of commensality between Prestwick and its suppliers. The commensal concept of 'dining at the table together' is met when Prestwick and its component suppliers must both share the burden of financing the ultimate customer during the construction phase until final delivery is made, thus allowing dining at the table together.

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46. Tacoma News Tribune, January 6, 1993, page E1.

4.3 Assemblers

The major manufacturers are in reality assemblers of parts, components and sub-assemblies, either made in-house or out-sourced from component suppliers, into the final airframe. Prestwick, as is the case for other major assemblers, out-sources about sixty percent of its components and parts needed to build their two models. This sixty percent buy-in of components creates a large infra-structure of component suppliers servicing the civil aerospace industry.

This supplier network completes the mutual beneficiality concept of the symbiotic changing relationships tested in this research. The major assembler needs the supplier infra-structure to operationalise their stated objectives of not increasing their in-house facilities and personnel levels beyond a pre-determined range. For previously stated reasons, primarily to control internal growth, Prestwick has decided to out-source or buy-in sixty percent of their parts. This stated policy of Prestwick's management creates a demand for products that can be met by component suppliers.

In turn, the component suppliers benefit from the outsourcing policy of Prestwick by meeting this demand for parts and components. This demand creates orders for their firms, the amount of which varies individually from ten to nearly one-hundred percent of their overall capacity. Thus the mutually beneficial criteria is completed full circle and is met by operation of the purchaser-supplier interactions and in the fact that both parties to the transaction benefit from the relationship. (Mutual beneficiality established.)

4.4 Marketeers

The major assembler is the dominant partner in the commensal relationship if for no other reason than it is the entity that secures the order

from the airline customer. However, in this study, the small and medium sized component suppliers interviewed were by definition much smaller than Prestwick. The marketing effort is performed by the one partner who secures the sale, thus providing the need for an aircraft to be built. Part of the commensal relationship as defined establishes that no harm is done to any of the participants because of the relationship. Although Prestwick (in actuality, the central sales office at corporate headquarters) provides the sale, it does not incur harm because of the benefits to the suppliers. The SME component suppliers benefit from the subsequent purchase orders for components and parts needed to make the build at Prestwick. The commensal relationship is thus established as mutually beneficial and not harming either of the participants to the changing relationship.

Another aspect of marketing is the viewpoint of changing relationships between the marketing by the SME component suppliers and the purchasing department of Prestwick. This is discussed in the next chapter under purchasing/marketing interface.

5.0 STRATEGIC ENVIRONMENTS

5.1 Global Considerations and Changes

The global operating environment of the civil aerospace industry includes global sphere of operations, and global competition considerations.

5.1.1 Global sphere of operations

The civil aerospace industry, its' supplier base, its' customer (airline) base, sourcing of raw materials, and government regulations are truly global in nature.

Airframe manufacturing competition is global with major assemblers in North and South America, Western and Eastern Europe, Australia, the

Near-East, and the Far-East. The component and material suppliers are more geographically disbursed than the assemblers; virtually every country that has some industrial capacity probably has participants in the aerospace industry.

The customer base is world wide and is gradually shifting from advanced industrialised countries to newly industrialised countries, as the newly industrialised countries (NIC's) civil airfleets are upgraded and modernised. Consequently, civil aerospace marketing strategies and planning must reflect this global shifting of customer base.

Marketing strategies are shifting geographically because governments of many countries are deregulating their airline routes, or already have deregulation in place. One effect of deregulation is to change the number of airline customers available to the airframe assemblers. A second effect is to change the type of equipment purchased by the existing traditional markets. For example, connecting airlines have different equipment and capacity requirements than long-distance intercontinental carriers.

Production and global procurement methods are changing in response to increased competition by fewer aircraft assemblers. For example, each new aircraft model forges a new consortium of major assemblers and component suppliers, who may be direct competitors on other aircraft models.

5.1.2 Global competition

The second aspect of the global operating environment faced by aerospace firms is global competition.

The firms' exogenous competitive factors are increasing in the civil aerospace industry as new firms emerge throughout the industrialized world and from third world countries. For example, competition is arising from

China, Peru, and other countries not considered a competitive threat a decade ago. An unknown factor is how the break up of the former Soviet Union into separate countries will affect their civil aerospace industry's competitive position.

The big three aircraft assemblers (Boeing, Airbus Industrie, McDonnell-Douglas) are attempting to build a complete family of aircraft models to meet diverse needs of their deregulated customers. The deregulation of airlines has created a market opportunity for smaller manufacturers (BAe, Fokker, Embraer) to build aircraft directly targeted at the regional airlines, thus competing head-to-head with the big three in this model range.

5.2 Government Considerations

The second general operating environment faced by the civil aerospace industry is the various interactions with governments. The normal concepts of governmental assistance in export promotion, tax incentives, technology and innovations support, export financing, payment guarantees, and marketing incentives, although applicable to the aerospace industry, are not inclusive and consideration must be given to other aspects of governmental actions, direct and implied.

"Interference in the affairs of the aircraft industry by the government became inevitable on the day that the industry took its very first gift of taxpayers' money to bolster research and development, rather than relying on its own funds."[47]

5.2.1 State Involvement

The state's involvement has far-reaching consequences in two respects: encouraging and facilitating exogenous R&D for ultimate

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47. Reed, 1973, p. 70.

betterment of aircraft firms' products, and deliberately restructuring those aircraft firms to make them more amenable to technological progress. This involvement may be direct (e.g., Japan, France, Israel, Brazil) or may involve indirect persuasion techniques (e.g., Britain, U.S.A., Canada, Germany.) Todd and Simpson believe that the involvement of the state is such that the aircraft industry cannot be considered independent of the actions of the nation state. Baker et. al., (1988) argue that governments must be involved in varying degrees during the new product development stage of a new aircraft or aeroengine because the prohibitive costs cannot be sustained by private industry.

Several theoretical considerations are amplified as facets of nation-state involvement. These facets include:

- the majority of the global aircraft market is military oriented, although in mid-1992 the balance point may have been reached;
- the civil market is frequently reliant on government financing schemes;
- there is a formal reliance by the military complex on key manufacturers for nation-state security;
- government is involved even in the selection of plant locations;
- the industry is used for regional planning policies; and
- innovation and technology are dependent upon massive state funding in various forms or schemes as they are considered national assets.

Porter believes that governments deliberately "...promote concentration of activities by providing subsidies or other incentives to

employ a particular country as an export base - in effect altering comparative advantage - a role many governments are attempting to play today."[48]

An example of governmental altering of comparative advantage is location. The physical location of the manufacturing facility is generally found clustered in the traditional trading areas for each particular industry, around the major manufacturer, or where there is a skilled labour pool. Recent economic developments in Scotland and Wales support the view that persistent efforts by governmental agencies can change this trend by offering incentives for new plant start-ups or relocations to economically depressed areas. The Scottish and Welsh success must be tempered with the realisation that they have a large pool of highly skilled labour located in high unemployment areas, while other countries may not have such comparable labour resources. (Mason, 1985; Miesenbock, 1988.)

Porter believes that governments play a proactive role in influencing firms to locate their entire 'value chain'[49] in their country through tariffs and other barriers, and nationalistic purchasing policies. He defines a value chain as the integrated processes of raw materials, manufacturing and R&D at sites within the home or host country to the maximum extent feasible. His definition is consistent with the JIT manufacturing concept of concentrating on value-adding activities and minimizing non-value adding activities.

5.2.2 Implementation of State Involvement

To confront these problems, European governments implement their strategies using two fronts: inducing merger of their domestic firms, often

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48. Porter, 1986, p.30.

49. Porter's value chain consists of two main elements: (See C. 2. a. & b. for discussion.)
1. support activities - the firm's infrastructure, human resource management, technology development, and procurement activities; and
2. primary activities - consisting of inbound logistics, operations, outbound logistics, marketing and sales, and service.

under the rubric of state acquisition, or, forcing co-operation across international lines.

- Mergers are often favoured by European governments to command greater resources for R & D, and to make their aircraft industries more competitive with the U.S. giants. In the European context, merger and consolidation during the 1960's and 1970's was a favoured option capable of overcoming the problem of acquiring the resources necessary for innovating major aircraft programmes. The British, French and Italians subscribed to this strategy, with the Germans reaching the same conclusion by the early 1980's.

- The second form of political involvement in affairs of the European aerospace industry is government-induced international co-operation, which is often considered the viable alternative to nationalisation.

Compensatory industrial offset agreements have become a way of life for exporters of most major military aircraft, and are more frequently entering negotiations for civil aircraft as well. These agreements are usually conceptualised within the framework of import substitution strategies. (Termed 'hostporting by Moreland, 1990.) Substitution is where domestic manufacturing arrangements are made for parts or components used directly in the aircraft, or other assembly arrangements are entered into. For example, British Harrier jets purchased by United States Marine Corps are assembled in the U.S. by McDonnell-Douglas, and utilise a pre-determined percentage of components sourced in the States. These offset agreements usually increase the cost of the aircraft and require more spending by the military than outright purchases, but other national considerations weigh heavily in the decision.

A recent example of forcing co-operation across international lines, albeit in the military sector, was the British Government's 1991 decision to

use the American firm IBM as the prime contractor for a new helicopter model. The Royal Navy uses a anti-submarine and surveillance helicopter that has more electronics and computers aboard than the value of the aircraft itself. IBM was the successful bidder because of this fact; their argument was that the airframe is well established (using a Westland helicopter in this case), but the electronics aboard were the primary cost and bid considerations. The British government forced Westland, in effect, to cooperate with IBM to be a subcontractor participant in the contract.

Governments can influence commercial aircraft manufacture by several direct and indirect methods. In many countries governments can compel state airlines to buy designated aircraft. This 'captive customer' concept can be used to provide the initial orders for a new aircraft that often makes the difference between success or failure of a model.

Other direct government influences are specific R&D contract work for military aircraft or engines that have a cross-over value to civil aircraft, (British and American format), or outright grants or loans justified by either national balance-of-payments reasons or maintaining employment levels. (French and German format.).

Indirect influences include providing attractive financing packages or leasing arrangements to domestic or foreign purchasers of commercial aircraft, and government-maintained research institutions such as the U.S. NASA, the British Royal Aircraft Establishment and the Soviet Central Institute of Aerodynamics and Hydrodynamics.

5.2.3 Initiation of Aerospace Industry into the State

The 'Infant Industry Case', as defined by Todd and Simpson, compares the initiation of the aerospace industry within the advanced industrialised countries:

- Britain & the United States started with state owned facilities, but quickly changed to having the state providing R & D monies and development funds to private aerospace companies. Significant manufacturing sites owned by the state were not sought, but some 'shadow sites' were maintained and usually leased to private companies, available for wartime recall if or when needed.

- Switzerland, Belgium, France and Germany have developed state owned manufacturing facilities with indigenous design work as well as building under licence.

- Infant Industries in Newly Industrialised Countries (NICs) - reasonably adept at licence production, limited indigenous designs. The manufacturing facilities are usually a branch of the Air Force, as in Argentina, Brazil, Taiwan, and Egypt.

- Protected markets - usual proclivity of governments to protect their aircraft industries by requiring state airlines to place orders with them resulted in much higher operating costs and had been abandoned in most cases by the 1960's. It has been estimated by Todd and Simpson that BOAC suffered operating costs ten to fifteen percent higher on its fleet of required Vickers VC-10 jetliners than the comparable operating costs of Boeing 707's. These higher operating costs necessitated operating subsidies by the British government to compensate for the additional fuel, spare parts, and maintenance costs.

5.2.4 Government Intervention

The theoretical setting for governmental intervention is characterised by three important tendencies:

(1) Governments seeking concentration of economic and political power. High technology, high prices, and high visibility, all encourages nation-state influence with the civil aerospace industry.

(2) Transnationalisation of markets, production, procurement, all of which necessitate global financing and cost-sharing.

(3) Importance of control over technology to accumulate economic and political power and to control transnational relations favourably by the host governments. A majority of the technology is perceived as critical for national defence or international movement of funds purposes, thus implying or tempting implementation of nation-state controls.

Because of interwoven needs for state security, some countries have developed a pattern of permanent receivership whereby a designated number of companies which are considered essential for national defence purposes are recipients of state attention in order to guarantee their continued stability and success.

This government intervention is called by various names, but the intent is common:

- 'Bail-out imperative' is a guarantee of the U.S. and British governmental support whenever a financial crisis arises and the company is an indispensable contractor within the defence procurement scheme. The government commitment is to ensure the on-going viability and success of the enterprise as a supplier entity. In the United States this can take the form of direct loan guarantees, as in Lockheed's case in 1971. The collapse of the company would have resulted in a loss of 10,000 jobs, with a spill over affecting 14,000 subcontracting jobs in the United States and 7,000 workers for Rolls Royce in Britain. The bail-out attempt was successful and avoided a Lockheed bankruptcy, but it did create a furor amongst the public.

Another form of reactionary government 'bail-out' intervention was illustrated in February, 1971, when Rolls-Royce announced that it was filing bankruptcy. This announcement shocked the aerospace industry, which

had not been informed about the closely-guarded decision. John Stenhouse, Minister of State, stated the primary reasons as excessive losses on the RB211 engines being developed for Lockheed ($264,000 loss per engine), which had been costed by engineers and not accountants; as well as lax controls over other development costs, which were amounting to £190 million per annum by 1971, eventually totalling over £1.5 billion by 1980. The British government felt justified in nationalising the company immediately because of international prestige, national defence, a large number of jobs at stake, and badly-needed exports. (Reed, 1973).

Reed's previously-mentioned comment, concerning the difficulty in educating successive British governments about the enormous front-end costs of new model development, is illustrated by the 1971 decision to let Britten-Norman on the Island of Wight go into receivership. At the time it went into receivership, the company owed only £600,000 in production loans to the government. It eventually was purchased in 1976 by Pilatus Aircraft of Switzerland. The Islander light transport aircraft that had incurred these high development costs, which also caused the failure of Britten-Norman and Fairey Engineering, has become highly successful and is being built in four countries. Pilatus-Britten-Norman (PBN) completed (and sold) the one-thousandth Islander aircraft in 1982, and the model is still in production. Commercial aircraft are generally considered a financial success after three hundred aircraft are sold.

- Nationalisation - European approach to permanent receivership, also used by Britain until recently. The French are particularly prominent in this approach, with piecemeal acquisitions since the 1930's. The French government currently owns over seventy percent of their indigenous aerospace industry. By 1981 the French government had acquired forty-six percent of the only sizable Tier I company remaining in

operation, Dassault-Breguet; they have, however, kept it outside the Aerospatiale structure. (Todd & Simpson, 1986).

The French record of nationalisation renders at least four catalysts to permanent receivership discussed above:

(1) The first is associated with the desire to augment national defence capability, which was the reason for the first nationalisations in 1936. (The U.S. justifies 'surge capacity' subsidies for the same reasons.)

(2) Secondly, the state will intervene for punitive reasons. This reason was given by the French in 1945 when they nationalised those firms which had collaborated with the Germans during the WW II occupation.

(3) Thirdly, the state rationalises increasing capacity to a scale of international competitiveness to which the industry is not willing to undertake. (e.g., Aerospatiale in France, MITI influences in Japan.)

(4) Finally, firms are acquired as part of the bail-out imperative, previously discussed, to prevent their collapse or disappearance. Examples are SOCATA in France, the UK-owned Fairey SA nationalised by the Belgian's and reconstructed as SONACA, and Shorts in Northern Ireland by the British. (Todd & Simpson, 1986.)

The British nationalisation experience culminated in the mid 1970's when the Labour government attempted to acquire most of the aerospace industry in order to facilitate long-term viability, unification of production units, integration of the industry's interest with those of the government, furthering of flexible operations, worker participation, and diversification.

This controversial nationalisation programme occurred at a time when the industry was operating at profitable levels, but was justified by the government because of the overwhelming reliance on public research and development monies. The state eventually realised that largeness in itself

does not promote economies of scale, and with subsequent changes in government, started privatisation of the industry in 1980 and completed it substantially by 1985.

The nationalisation programme completed the consolidation of the remaining aerospace companies into what is now known as British Aerospace, Plc. The British Government retains one special share, which prevents the company from being acquired by foreign owners.

5.2.5 Capacity Considerations vs State Needs

Government policy for airframe plant expansion is another important and sensitive area for manufacturers. Airframe manufacturers are reluctant to build plant capacity beyond their expected peacetime usage levels. There is also wide-spread belief throughout the industry that earnings are too low to justify any excess capacity investment risk. (Todd & Simpson, 1986).

The defence departments, however, want a rapid expansion capability, realising that in future wars there will not be time to build the infrastructure that the Western world enjoyed in the past. A partial solution to the defence need has been acquisition of the shadow factories previously mentioned, but by many politicians this is considered an unsatisfactory solution.

During the Korean Conflict the U.S. Defence Department's policy of no 'brick or mortar' to prime contractors was a method of forcing more subcontracting on the airframe manufacturers. This surge capacity plan is effective only beyond the point where current industry plant capacity can no longer handle the production load and subcontracting is the only viable alternative.

This military policy of forced subcontracting has a beneficial effect on the component and supplier industry in the civil aerospace sector, as

manufacturers have chosen to develop deliberately this capacity in lieu of adding plant capacity themselves.

5.3 Business Considerations

The third operating environment faced by the aerospace industry is the general business environment. This business environment is further classified into transaction cost analyses, increase in dependency (termed (1) physiological dependency and (2) Japanization of Western business), and behavioural patterns of the firm.

5.3.1 Transaction cost analysis

Transaction cost analyses is useful in understanding symbiont relationships within the civil aerospace industry and is referred to throughout this dissertation. The understanding of the complexity of change and interaction between firms is made easier by use of this method of economic analysis of the firm, and its relationship to transactions. (See Literature chapter for a discussion about transaction costs.)

Williamson's three classifications of asset specificity are strongly applicable to the civil aerospace industry, especially from the specified physical and human asset perspectives. For example, many of the civil aerospace dies, jigs and tooling are product specific and not interchangeable within the same firm, nor with other firms within the industry. In a similar manner, the steep human learning curve is well documented and becomes part of the profit projections within the civil aerospace production planning process for each new model. Both of the physical asset and human asset examples or factors, amongst others, make it difficult for a newcomer to displace an existing supplier to a participating partner in the transaction. Although this argument is not unique to the civil aerospace

industry, it is important because of the intensity mandated by safety requirements and on-time delivery schedules applicable to this industry.

5.3.2 Dependency factors

This sub-area of the business environment is further classified into two operating factors: i. physiological dependency, and, ii. Japanization of Western Business.

(1) Physiological dependency factor

Part of the definition of symbiosis refers to the fact that symbiotic organisms lose part of their physiological independence because of their close relationship. (Gotto, 1969) This natural world phenomenon has its parallels in the business world also. Oliver and Wilkinson (1988) discuss a theory of dependency relations as a result of modernisation of British Industry. Their theory is that as companies begin achieving JIT production, procurement and delivery methodologies, there is a dramatic increase (authors' words) in the dependency between the various agencies involved. They develop their argument that as one party becomes dependent upon the other, power resides implicitly with the non-dependent party. Heterogeneity of goals and resource scarcity provide the motivation to exert power and influence by one party; closer relationships and lucrative contracts provide the incentive to become dependent by the other participant. Prestwick indirectly addresses this subject through their management goal of fostering 'long-term partnership' type of relationships. Although their management does not state that this increases dependency of both parties upon each other, it may have this ultimate result.

(2) Japanization of Western Business

The phenomenon of Western businesses adopting practices and procedures of Japanese businesses has been termed 'Japanization'. The importance of the broad social, economic and political environments often

termed Japanization are based on high-dependency relationships. Oliver and Wilkinson stress the importance of achieving a 'good fit' of the Japanese practices to Western businesses, and not expecting the adapted practices to be a package for automatic success. In summary, the authors feel that the Japanization of British industry is a response to the problems encountered in international competition. This response is appropriate for the civil aerospace industry, which is being threatened by newcomers from Japan and other Pacific rim countries, as well as narrowing, but intensifying, competition between Boeing, McDonnell-Douglas and Airbus Industrie.

The civil aerospace industry may be a beneficiary of Japanization of the automotive industry in Britain, as many suppliers serve the aerospace and automotive industries simultaneously. Prestwick's management stated that it appears easier to implement JIT delivery schedules and quality assurance standards amongst those suppliers who are experiencing similar requirements from the Japanese auto manufacturers located in the U.K. Conversely, several of the SME managers interviewed stated that it is more profitable and less emotionally demanding to serve the aerospace industry than the automotive industry, which they perceive as cut-throat and unreasonable in their demands.

5.3.3 Behavioural patterns of the firm

The third factor involved in the business environment of civil aerospace firms are exo- and endogenous behavioural patterns. This discussion is often from the perspective of internationalisation because of the global sphere of operations previously discussed. It also refers frequently to the literature because it is general in nature and reflects an overall perspective, not necessarily just civil aerospace.

The behavioural characteristics discussed in this section include: size, endogenous factors, marketing policies, marketing information,

operational characteristics, and interactions between the firm and its management.

Size

The literature suggests that the larger of the small and medium-sized component suppliers are more likely to engage in exporting or other forms of internationalisation. (Withey, 1980; Schlegelmilch, 1983; Roy & Simpson, 1981.) This finding is important to the SME component suppliers because of the broader implications of civil aerospace participation being global in nature.

Endogenous Factors

The attitudes of the decision-maker are important to the commitment of the firm's resources to exporting and the actual availability of resources for international activity. SMEs must be aware that even if they do not directly export, their aerospace product is marketed worldwide, which necessitates their commitment to global service and repair, market demands, and consumer standards.

Marketing Policies

Product characteristics found to be most successful by Beamish and Munro as a marketing strategy are: a narrow product line, products that are complementary in nature, and either high technology products or those that are unique or distinguishable. Many of the SMEs are very specific in their aerospace product line bidding, and by definition are unique and distinguishable.

Careful market targeting and constant review of market needs is found in successful small firms by Holden (1986). Several of the SMEs commented that they enter the civil aerospace industry for specific products and then may not bid on others. All of the interviewees were conscious about the changing market needs of civil aerospace and the inherent

dangers of becoming to dependent upon one industry. Flexibility of management and a willingness to shift to other external markets if necessary are other important characteristics highlighted in Holden's study, which supports the research findings in this dissertation.

Marketing Information

The importance of specific, in contrast to general, market information having a more positive influence on manager's decision making is advanced by Sood and Adams (1984). The SMEs acquire specific market information by attending the international airshow held in Britain and sometimes the one in France.

Cavusgil (1980) observes that foreign market research increases in formality and importance as firms progress through the internationalisation process, and that management takes more time to assess foreign market potentials as they acquire experiential knowledge. This observation was primarily implemented by the SMEs attempting to enter the U.S. market through contacts developed at airshows or from 'piggy-backing' of products destined to US markets by large manufacturers, i.e. Prestwick.

Operational characteristics

In their book, 'Restoring Our Competitive Edge', Hayes and Wheelwright contend that a major contribution to declining U.S. productivity can be attributed to the short-term myopia of managers and their reward systems. "Although government policies that over-constrained or undersupported U.S. producers may have contributed to these problems, their long-term solution is not likely to be based on changing government tax laws, monetary policies, and regulatory practices, getting unions to be more reasonable, or developing alternative energy sources. Instead it will require fundamental changes in certain management attitudes and practices that have undermined American companies' ability to use technological strength

- the ability to produce better products using better manufacturing processes - as a competitive weapon."[50]

The SMEs seem to recognize the constraints of these policies, but often are at a loss as how to overcome them and circumvent them to their advantage. In spite of recent efforts by both the British and American governments, SMEs are perplexed by the exporting programmes and assistance supposedly offered.

Cash flows, and the resulting continual need for their planning, is another operational aspect involving the resources of the firm. The SMEs were extremely critical of any alterations in their cash-flow relationships with the major assemblers. They argue that their bids are so competitive that there is not a provision for delay of payment consequences in the price. Several comments were made that a major assembler can 'bust' the smaller SMEs by simply delaying payments.

Suzman and Wortzel (1984) advocate the importance of the firm's commitment to maintain a visible presence in any markets entered and to continually supply the export market through long-term production set aside. They believe that if a firm enters a market it should provide adequate production volumes to service that market and remain in it for the long-term. An apparent dichotomy exists between the SMEs belief that it is dangerous to become committed to one major assembler, and the need to commit to a market for the long-term. In actuality however, the two diverse goals can be met. The SMEs attempt (often not successfully in the short-term) to not commit more than a certain percentage of their production capacity to one manufacturer. However, they do seem committed for the long-term to their product lines, often because they have developed a niche market. In

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50. Robert Hayes and Steven Wheelwright, 'Restoring Our Competitive Edge, Competing Through Manufacturing', John Wiley & Sons, New York, 1984, p. 7.

addition, purchasing requirements by the majors are changing to require long-term service support by the SME for their product, especially in the situation where it is a complete component. (e.g. an instrument or avionic, complete assembly etc.)

Interactions between firm and management

Elwood Buffa (1984) recognised that the decline in Western productivity was due to poor management practices in Britain and America. He believes that these countries turned away from good management practices after WWII and started emphasizing marketing and mergers instead of manufacturing excellence. He advocates establishment of a cultural change that incorporates quality, price competitiveness, recognition of worker values and minimal inventories, and a competitive manufacturing strategy. One of the advantages for working for a SME that management advocated is the close interaction between labour and the managers. Many of the interviewees stressed their good relationships with their labour force and how they participated in daily operations. This concept was not verified by this research, but was observed by the researcher on several occasions.

Shetty and Buehler's Eds. (1987) augments Buffa's reasoning for reversing the declining productivity of Western firms by implementing seven changes: new capital investment, improved labor-management relations, reduced government regulations, revitalizing and restructuring corporate management, increased emphasis on manufacturing management, increased innovation, and improved productivity and quality. Kenneth King, in a separate chapter in the above editors' book, states that firms must recognise that 'the majority of defects, and errors, are caused by management'. Both of the above articles summarise the findings previously discussed above and included in the literature search chapter.

5.4 Strategic Environment

The strategic environment that participating aerospace firms operate within is further classified into three areas: Porter's five competitive forces, strategic planning in general, and internationalisation of the firm. These strategic environments are supported by the business environment, and defined by both governmental and global environments as previously discussed.

5.4.1 Porter's 'Five Competitive Forces'

Porter postulates five competitive forces which drive a firm to compete in its industry and within its underlying economic structure:

(1) Threat of entry - new entrants from other countries, e.g., aerospace work encouraged by MITI for heavy industries in Japan; or through new competitors within the firm's country. The SMEs interviewed believed almost unanimously that competition is increasing from new firms becoming British Aeronautics Authority (BAA) certified within Britain, and from new countries competing for aerospace work including Japan, Korea and China.

(2) Threat of substitution - this threat has limited application in the aerospace industry, but is certainly existent. The biggest threat is from alternative forms of high-speed ground transport. 'Bullet trains' between Britain and France may decrease the passenger count of airlines. The completion of the 'chunnel' connecting Britain with the continent may make driving more popular. A secondary threat to the component and material suppliers are the introduction of new products, parts or materials. New composites are being introduced that may make aluminum obsolete or of limited application. Fly-by-wire technology is replacing hydraulics and cables that have been supplied by some firms for eighty years.

(3) Bargaining power of buyers - the SMEs interviewed expressed considerable vulnerability to buyers. For example, many of the SMEs believe that the expressed goal of improving communications by Prestwick's top management is not being implemented by middle management and that buyer pressure is still exerted purely on pricing considerations. The major assemblers feel

the airline customers are exercising more bargaining power than ever because of the narrowing of the technological gap between the three remaining competitors.

(4) Bargaining power of suppliers - as explained in later chapters, the majority of the SMEs believe that they have a small amount of influence over their suppliers, most of whom are large multi-national corporations. This has been partially overcome by Prestwick negotiating blanket purchase orders, with authority given the SMEs to draw from this purchase pool. Prestwick buyers expressed some concern over single-sourcing policies as giving to much power to suppliers, which they feared would raise prices in the long-term.

(5) Rivalry among current competitors - Porter believes that competitors are mutually dependent. Mutual dependency is defined by Porter as competitive moves by one firm having noticeable effects upon other firms competing in that industry. This research found this concept to be applicable to the SMEs interviewed, and amongst the major assemblers as well.

The implementation of single (or rather limited) sourcing policies by Prestwick has increased this competitive rivalry amongst the supplying SMEs. An interesting collaboration has resulted amongst the SMEs, however, in that the firms not winning the contract may often be asked by the successful bidder to assist in filling the order. Single sourcing implies, amongst other factors, that the successful bidder will set aside capacity to supply the entire build programme and provide surge capacity as needed. This implication often forces the successful SME to sub-contract portions of its build to other qualified and certified suppliers, who were former competitors for that particular product.

5.4.2 Strategic planning

The symbiont change process results from a conscious decision that requires various degrees of strategic planning by the participants. The general planning parameters depend upon the endogenous and exogenous

factors and environments operating upon, and within, the firm and its management. Planning and cost analysis is a necessity for small subcontract firms in their competitive environment. Tobin, Mercer and Kingsman (1988), in their study of 24 firms preparing quotations for orders, find that the estimation process must include planning for costing, production processes, production control and pricing, all of which imply strategic planning by the owner or manager. The weakest area consistently found in this research amongst the SMEs was their provision for product costing. In many cases the SMEs would cost out the original bid and then not review their product costs once they were awarded the contract and the build began, barring large unforeseen price increases. This practice may well result in non-detection of poorly priced bids or changing conditions which affect the build life of a component.

An area of strategic planning often overlooked in the literature is the issue of international purchasing by smaller firms. The firms interviewed in this research did minimal foreign purchasing of their parts and materials, with eighty-five percent preferring to resource locally. Lars Hallen (1982) researched this subject and found three factors which influenced international purchasing:

(1) The need for international purchasing due to current market conditions; (encompassing domestic availability);

(2) The desire to purchase internationally as evidenced by buyers' attitudes; (encompassing foreign trade policies, opinions, and quality of alternative sources); and

(3) The ability to execute international purchases administratively. (encompassing market knowledge, cultural awareness, foreign orientation and mastery of foreign languages.)

Subjective factors have an important effect on the strategic decision-maker as well as the firm. The first factor, that decisions are not made in a fully rational mode because of lack of information, small number of

alternatives, and presence of uncertainty, affects the rationality of the decision.

A second subjective factor on strategy is that the key decision-maker is often hampered by the quantity and quality of objective information, which is generally limited in international ventures. (Cavusgil and Godiwalla, 1982). These observations were verified by the research respondents, who often expressed frustration about not knowing where to source internationally for suppliers meeting the necessary quality and delivery standards.

5.4.3 Internationalisation of the firm

Internationalisation is designated an important strategy in this study because of its impact upon the small and medium-sized component suppliers (SMEs) marketing and procurement planning. The SMEs are confronted on two fronts by internationalisation: global major assemblers, and demands by foreign customer requirements for a percentage of local content in any product sold to them.

The major assemblers are limited in number and are literally located throughout the industrialised world. This limited market base necessitates a global marketing strategy that is paradoxically reasonably defined. (All major manufacturers share common quality, delivery, and to a degree, assembly demands.) This limited base forces a decision on the SMEs to bid internationally or just in-country. In either case, to make an informed decision management must be aware of international implications, procedures and rewards.

The foreign customers, usually national airlines in many developing countries, require a designated percentage of local content in the aircraft. This requirement passes through to the SMEs who have to be aware of potential parts or components available in that country to help meet the local

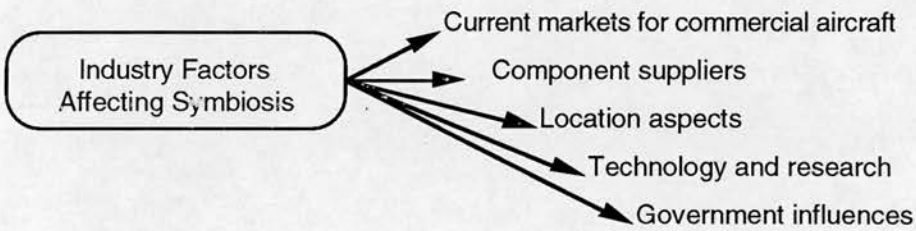
content rule. The smaller SMEs often ignore this requirement and source locally, passing the responsibility to Prestwick for meeting this requirement. However, the SMEs are still affected because the major assembler may be forced to place orders overseas that normally would have been bid locally.

The next section discusses specific industry factors that may have an influence upon symbiotic change within the civil aerospace industry.

6.0 INDUSTRY FACTORS INFLUENCING SYMBIOTIC CHANGE

Five factors of particular significance which influence symbiotic change are discussed in this section. The arbitrary selection of these five is not intended to imply that other factors are not important. These factors are highlighted in this discussion because of their bearing upon symbiosis, uniqueness to high technology industries or geo-political implications.

Figure One- Industry Factors Affecting Symbiosis



6.1 Civil Aircraft Market

The current market for civil aircraft is composed of four basic needs:

(1) Long distance, transcontinental, high volume routes, which require long-range, wide-body aircraft. (747, DC-10)

(2) High volume, short to medium range routes, including feeder lines to international flights. Wide-body, medium-range aircraft are the preferred type for this need. (757, 767, A320, A330, DC-9)

(3) Regional routes of varying volume, which usually utilise narrow body, lower-seating-density aircraft. (BAe 146, 737, Fokker, Embraer)

(4) Air freighters of all types and sizes, preferably easily convertible between passenger and freight configurations. (BAe's QC 146)

1988 was an exceptionally healthy civil aircraft sales year, with orders running at record levels continuing into early 1990. All three major manufacturers, Boeing, McDonnell-Douglas, and Airbus Industrie have been building new factories, expanding production lines and entering risk-sharing joint ventures with partners in Europe, Japan, Korea and China.

The anticipated replacement of aging aircraft did not occur, with only about twenty percent of the predicted three hundred actually being replaced in 1988. The new orders are apparently coming from new air transport business, perhaps as a result of the deregulation of U.S. scheduled services, and the beginning of EEC published regulations opening up routes beginning in December, 1987. (Flight International, 7 October, 1989).

Record sales are having several negative effects on the airframe manufacturers, as increased production rates have led to a serious shortage of skilled personnel. Boeing is having to contract for skilled personnel from Lockheed to work on its 737's, 747's and 757's at Everett, Washington. Unions are tempted to increase their demands, with BAe, Boeing and Rolls-Royce settling prolonged machinists' strikes in 1990; these strikes adversely affected their scheduled delivery dates and subcontractors' work flows.

International cooperation between airframe assemblers and engine manufacturers continues to flourish. British-Soviet cooperation appears imminent as BAe, Plc., discusses co-production of the model BAe 146, and Rolls-Royce discusses co-production concerning several jet engines. Japan's MITI has authorised a study into a 75-seat airliner, with an

international partner to be selected in the mid-1990's. MBB of Germany and Catic of China have agreed to continue pre-development work on an 80-seat fly-by-wire design incorporating composite materials for much of the primary structure and full electronic cockpit. By the end of 1989 twelve McDonnell-Douglas MD-82's assembled in Shanghai were in service with Catic Airlines of China. This programme was extended to a total of twenty-five aircraft to be assembled in China by 1991.

Commercial aviation airliners vary widely in function and size. Some airliners, e.g., the Boeing 700 series and Airbus, are readily convertible from passenger to cargo, others, like the Concorde, are narrowly specialised for passenger service. British Aerospace is advertising heavily its 'quick change' QC146 model, which is designed to be used around the clock. The QC146 can be configured as a passenger carrier during day-time hours and converted to a night freighter in approximately one hour. An interesting secondary factor for these quick change models is their operational quietness, which is mandated for nighttime service over populated U.S. centres.

The market must not only cater to the long-distance carriers, but, especially in recent years, must also recognise a 'hole in the market'. The marketing edge in designing a new model with appropriate seating capacity. This is illustrated by the recognised need for feeder-line operations, which link minor airports to the major international centres. Their expressed preference is for aircraft seating capacity of 120 to 150. The same aircraft designed for feeder lines may also be suited for shorter third world airfields and their different operational needs, thus extending the market and useful life of these aircraft to another dimension.

A significant positive factor for the aircraft manufacturers is the aging of the aircraft fleet of many of the world's airlines. As mentioned earlier,

however, replacement of the aging fleet has not yet commenced in significant numbers. Recent spectacular fatal accidents or near-accidents highlight the problems of detecting metal fatigue or other structural problems inherent with prolonged usage of aircraft. These replacement aircraft may have to be purchased for safety reasons even though the airlines prefer to delay modernisation for several more years because of operational and financial considerations.

Surprisingly this apparent bonanza to the airframe and engine manufacturers has created a dilemma amongst them. The engine manufacturers are on the verge of breakthrough technology for a new generation of super-high temperature by-pass engines that promises to reduce operating costs, perhaps by as much as twenty-five percent. Some of the airframe manufacturers are holding back their third generation designs awaiting this new engine technology, while others are down-playing it and recommending replacements from the second generation aircraft currently in production.

Another positive factor for the aircraft industry is the deregulation of the airlines in Europe, which officially began in December, 1987, and to be completed by 1992, when the European Commission published a series of directives and regulations. Deregulation is likely to accelerate an existing trend to acquire narrow-body aircraft for short/medium haul routes crossing national boundaries with increased turn-around time and reduced maintenance costs.

Many of the regional airlines are seeking a 50 to 100 seat aircraft, to be used in connecting service to the national carriers. BAe and Fokker both offer the choice of turboprop or jet aircraft, with the other manufacturers concentrating on jet aircraft only. (Aviation Week, June 20, 1988). By 1992, Embraer plans to have its jet powered EMB-145 air-certified; this model will

seat between 40 and 60 passengers. It is aiming this model specifically at the U.S. market, for the deregulated 'hub and spoke' operations there. DeHavilland of Canada is promoting a stretched turboprop version of its Dash 8 commuter aircraft, seating 70, for this same type of market. As the European airlines become more involved with decentralisation, they likewise will be seeking the smaller 50-100 seat aircraft for 'hub and spoke' operations that will probably become standard throughout Europe. The present problem of limited access to air rights over sovereign countries should be eased by existing regulations, some of which do not take full effect until 1992.

The climatic political upheaval in Eastern-bloc countries, the continued recession in many Western countries, and the full impact of the Persian Gulf War are having repercussions on the aerospace industry and its customer - the civil airlines.

- The change in political structures in Eastern Europe has restructured old business connections and opened opportunities for new relationships, customers and competitors. Several of the countries are still politically unstable, making long-range planning difficult at best for the aerospace manufacturers. The economic drain on West Germany because of unification has impacted its aerospace industry, of which the total effect is unknown as of this dissertation. The possible near-bankruptcy of the Soviet economy combined with the newly formed coalition of Independent States may impact their civil aerospace programme, possibly for years.

- In excess of ten airlines declared bankruptcy during 1991, three of them very large customers of the manufacturers. This factor alone impacts the number of used aircraft available throughout the world; as well as making routes available to cities that had previously been considered 'closed', e.g., London, New York and Los Angeles. The

continued recession in the United States, Britain and much of Europe has impacted airline travel negatively, replacement of aging aircraft, and possibly start-up of new SMEs supporting the aerospace industry.

- The Persian Gulf War had several impacts upon the aerospace industry. One impact not anticipated was the decision by British and American defence departments to not replace their aircraft losses. Both governments justified their decisions presumably because of decreased needs for defence, given the current world political climate. This resulted in BAe and Boeing announcing downsizing of their military assembly operations, making personnel available for the civil sector or redundancy. The war did cause increases in jet fuel prices, which had negative financial effects on the civil airlines; many of them already experiencing their largest annual operating losses in recent years. Commercial airline traffic did decrease during 1991, partly because fear of terrorism and other retaliatory side effects from the war. The war effectively immobilised at least three national airlines of the Arab countries involved, Saudi Arabia, Kuwait and Iraq for longer than a year. The long-term effects of this war will not be known for several years, but it has a definite impact on the civil aerospace industry in Britain and the United States.

Post-war civil airline production has been decreased because of the down-sizing of the military aircraft build, and the continued recession throughout much of the world. Military aircraft R & D programmes has a similar effect upon civil aircraft as auto racing has to passenger cars - the testing ground for new materials, concepts, electronics and other innovations. With a decreasing military aircraft budget the civil aerospace firms will have to bear these costs directly. On February 13, 1992, BAe Plc., announced 900 job cuts in the regional aircraft group, which includes Prestwick. BAe cited the continued world-wide recession and cuts in

defence budgets as the primary reasons for these personnel cuts. (Wall Street Journal, p. A12.)

Military cut-backs may also affect the civil sector because plant expansion capital outlays are very dependent upon total capacity, including military aircraft. With the current decrease in the military build, the civil sector may not economically justify a new plant or enlargement of a present facility. Boeing sited these reasons for cancelling the construction of a composite parts 'state-of-the-art' manufacturing facility. (Tacoma, The News Tribune, January 23, 1992, p. A-1). By mid-1992 all of the major airframe assemblers have announced numerous cancellations of aircraft ordered on option and outright cancellation of firm orders by several airlines. Announcements of new orders, typically heavy prior to a major airshow such as Farnham or Paris is considerably down also. New orders for Boeing and Airbus aircraft are running at less than half the annual average as of August, 1992.

The most recently available production figures for all the major manufacturers is shown below in table one. The purpose of this table is to indicate the number of unfilled aircraft orders, additional options on aircraft which may be converted to firm orders, the number of aircraft delivered through December, 1988, current monthly production rates, and notes on status of the model.

TABLE 1: 1988 STATUS OF SELECTED AIRLINER MANUFACTURING

Manufacturer:	Orders	Options	Delivered	# Month	Status
Airbus Industrie					
A300	354		308	4	
A310	205		154		incl w/A300
A320	512		45	8	increase to 10

A321	87	66			del begins '94
A330	118	88			del begins '91
A340	94	59			del begins '91
Boeing					
727	1,831		1831		last built '84
737-200	1,144		1,144		last built '88
737-300	853		560	14	increase to 17
737 -400	171		61		incl w/300
737-500	168	82	16		incl w/300
747	934		735	5	
757	562		242	5	increase to 7
767	460		276	3	
British Aerospace					
146	163		124	3	
Fokker					
F28	241		241		last built '87
100	193	177	23		
McDonnell Douglas					
MD-80	1,075	488	635	8	
MD-87	95		26		incl w/80
DC-10	386		386		
MD-11	117	198			del begins '93

Source: Compiled from Flight International, Tom Hamill, 7 October 1989

6.2 Component Suppliers

The aerospace component supplier industry is a high value-added sector demonstrating high levels of productivity. Components are sourced from a cross-section of industries, firms and locations. Unlike the automobile

industry, where component suppliers tend to cluster around the major manufacturers, the aircraft industry is truly global in its sourcing linkages and geographical distribution. (Todd & Simpson, 1986). Another important difference from the automobile industry is the amount of assembly and manufacturing completed off-site and then shipped to the airframe assembler.

The structures of the component suppliers range from independent subcontractors, co-makerships, production under license, and research and development cooperation; each of which is further discussed below.

(1) Sub-contracting is still the dominant form of small and medium-sized companies doing business with the large aircraft prime contractors. There are approximately 8,600 subcontractors who regularly served the aerospace industry in Britain as of July, 1990, according to the Society of British Aerospace Companies. (Machinery and Production Engineering, 6 July, 1990.)

(2) Co-makership is a form of partnership, in which the subcontractor shares the development costs, risks and profits on a proportional basis. This form of partnership is beginning to be used more as the front-end development costs faced by the prime contractor are becoming prohibitively high. Current development costs of either a new airframe or engine are in excess of $4.5 billion. The Brazilian aerospace company, Embraer, is using cost-sharing to launch the 40 to 60 passenger jet EMB-145. Embraer invited ten prime U.S. subcontractors to participate with equity capital (not loans) in order to partially fund the research and development costs, launch costs and other risk capital costs of the new model. The participants were offered, in return, the opportunity to be the single source supplier for their particular component or sub-assembly. A modification of this practice is to invite certified suppliers to do the actual design of

components from engineer's specifications and drawings. Although this is common in the automotive industry, it has been adopted more slowly in the aircraft industry because of the stringent design and quality-control certification requirements of governmental agencies.

(3) Production under license is used when the major manufacturer does not have enough capacity, or 'surge capacity' as for example during wartime, to meet all immediate needs. Licensing allows foreign manufacture of the product, thus gaining a prolonged production run and economic recovery of the original development costs already incurred. BAe has successfully used this technique to extend the life of the model 100, which is built under license in Romania and Yugoslavia.

(4) Research and development cooperation is where the major manufacturer contracts for, or purchases new research results from a smaller, highly technical 'think tank' or research firm. This method of cooperation is becoming more popular as the prime manufacturer realises that small, highly-committed teams of researchers are better able to focus on basic research and product development than the larger firm. The prime firm becomes directly involved after basic design work and is responsible for product development, marketing and manufacturing. Prestwick has successfully utilised this technique by providing offices for these independent researchers or engineering firms at their Prestwick site.

Supplier relationships are changing in high-technology industries, especially by aerospace companies. The major manufacturers are expressing interest in longer-term relationships, reducing the number of suppliers, and including suppliers within the design process. Supplier ratings are being established with published procedures for rating suppliers. These ratings recognise quality achievements of suppliers, supplier

responsiveness, flexibility to change orders, and adherence to contractual delivery schedules amongst other rating criteria.

The prime contractors are forming teams of specialists to select new suppliers or to make periodic reviews of existing suppliers. These teams often include engineering, purchasing, accounting, production and quality-control specialists, as well as senior management personnel. (Burt, 1989; O'Neal, 1989).

Component suppliers are using innovative marketing techniques to obtain lucrative long-term contracts with major manufacturers. For example, B. F. Goodrich Company agreed to furnish Boeing 777 wheels and carbon braking systems without charge to Boeing. B. F. Goodrich will charge the airlines for replacement parts in the future, with parts valued at $3 billion over forty years. (Wall Street Journal, October 22, 1991, p. A3).

6.3 Locational Aspects

Although the physical proximity of suppliers to the major manufacturers is not regarded as an important consideration, location remains a factor because of the continued involvement of the nation-state in the affairs of the aerospace industry.

Plant locations are usually determined by political considerations, which often involves 'pork-barrelling' by committees and individual congressional members in the U.S. decision making process, and regional planning policies of the British government. Because the industry is so dependent upon governmental financial assistance, the normal marginal efficiencies of site-selection are overwhelmed by the needs of the state. Demand forces, especially national interest 'strategic' considerations, do not operate in the normal commercial spatial context. Locational factors for the

nation-state usually span entire nations and even beyond national boundaries to garrison forces deployed overseas.

During World War II, shadow plants - government owned, company operated, were built for passive-defence dispersion of facilities near, but not in population centres, which could provide the necessary labour force. The American version used dispersal of plants at least two hundred miles inland from the coastal areas; these were manned by both former aircraft manufacturers and non-aerospace firms, particularly those of the automotive industry. Even Tier III shadow facilities were built, known as 'modification centres'; they were sites for outfitting production line aircraft for operational military requirements. Many of these plants became permanent fixtures in the post-war activities of the industry. For example, Piper Aircraft Corporation utilises a former modification centre for its main manufacturing facility in Florida.

The other location factors are labour, weather, existing facilities, urban crowding, airfields and the local tax structure.

Supply factors, particularly labour, are of vital interest to the aircraft manufacturer. The significant aspects of labour supply include:

- sizable numbers involved, costs of which often exceed those of materials;
- orientation towards highly-skilled, which tend to be scarce and relatively expensive;
- tendency towards stability of employment; more of a European social factor than an American business consideration. Europeans, however, are beginning to adapt the business viewpoint: excerpts from an address given by Abel Matutes, European Commissioner responsible for small and medium-sized enterprise policy, at a conference in Brussels,1988, illustrates the changing attitudes in Europe:

> "...The point is that the most elementary truths are frequently forgotten. One such truth is that, if Europe is short of 17 million jobs and it is business that creates jobs, the only way to get to the root of the problem, rather than treat the symptoms and the effects, is by devoting more attention to business and less to jobs." (Partnership Between Small and Large Firms, Abel Matutes, 1989, p.3.;

- Because of the differential impact on costs, there is often a continual drive to reduce labour inputs and to introduce more automation into the assembly process. An excellent example of the impact of labour costs is customer airlines are demanding better consideration be given to routine maintenance and accessibility within the aircraft by their mechanics. Boeing invited customer airlines to have representatives set on their design board for the model 777. One of the innovative results from this board was a computer programme which simulates the human form moving around every compartment of the aircraft as it is designed. Even seasoned engineers at Boeing were surprised at how difficult some areas of the aircraft were to access; thus considerable re-design effort has gone into the 777.

In 1921 the Douglas Aircraft Corporation pioneered locational decision-making, independent of governmental decree, by choosing Los Angeles, California. The factors influencing its decision were the favourable weather for flight-testing and a solid base of skilled labour. Other major manufacturers soon followed this example, with the majority of firms locating in Southern California, Texas and Kansas. Piper Aircraft Corporation relocated in the mid-1950's to Florida not only for weather considerations, but also for a non-union workforce, minimised heating costs for large one-story factories, a favourable tax haven, and a site endowed with a large former naval airfield suitable for flight testing complete with a large factory building complex. (Former Tier III shadow plant.)

British aircraft manufacturers appear more reluctant to relocate; only a few have done so - DeHavilland moved from London to a new town, Hatfield, and Shorts moved from Rochester to Belfast. During WWII the British government also implemented the 'shadow' factory scheme, whereby duplicate plants were established in dispersed areas, devoid of R&D facilities. The original firm would supervise the construction of aircraft or components in these facilities, but the government would build and own the facilities. Established aircraft firms ran most of these shadow factories, e.g., Vickers managed three factories at Chester, Blackpool and Castle Bromwich. Other industries were pressed into service during the war, e.g., Rootes Automotive ran large plants at Speke and Blythe Bridge.

An ironic paradox is that the location factors necessary for aircraft manufacture - large labour force and airfields located away from urban centres, soon create congestion through the urban infrastructure that springs up around the new site. For example, the rural area around Boeing's massive greenfield 747 site at Everett, Washington, became within a decade a fully-developed urban complex. The area is now complete with local and regional governments, banking and financial centres, residential housing and apartments, hotels, hospitals and large shopping malls.

The component suppliers to the airframe assemblers are dispersed geographically and operationally. The wide geographical dispersion of suppliers is illustrated by the Boeing 757 programme, which purchases components from at least fifteen states other than Washington State in the U.S., and from other countries including Australia, Canada, Japan, Spain, China and the UK. The outside supplier content in the 757 aircraft can be as high as fifty-three percent, depending on the engine and avionics options selected.

The operational dispersion of the suppliers is illustrated by the fact that almost exclusively all of the component suppliers interviewed in this research participate in several other industries simultaneously with the civil aerospace industry.

6.4 Technology and Research

6.4.1 The 'greening' of the industry

A previous industry attitude of not caring what waste matters or pollutants were dumped into the air, how noisy engines were, and where airports were constructed, began to change in the 1950's with increasing government regulation. By the 1970's virtually every civil aerospace decision had to consider these environmental consequences:

- Engine noises on take-offs and landings must meet acceptable levels. Estimated noise reduction conversion costs to meet soon-to-be implemented stage-three noise classifications of urban airports exceed $2 million per airliner. Several Tier III companies are becoming specialists in this 'niche market' and were experiencing rapid growth during 1988 and 1989.

- New airports had to locate further from built up areas so that flight paths would cross as few cities as possible.

This 'greening' of the aerospace industry has increased its awareness of the type of research and development and continual planning necessary to meet its responsibilities in a wider community environment. The consequences of this impact are felt upon major assemblers and their SME component suppliers.

6.4.2 Exo- and endogenous technology factors

Todd and Simpson postulate a structural contingency model in which technology is partly exogenous and partly endogenous to the research and

development (R&D) levels of the firm. They believe that technology has an interactive approach with a firm's environment, when it is construed as emanating from a source external to the enterprise. They demonstrate that a firm has to operate in an environment that involves simultaneous two-way interactions between firms, the government, market demand and technological (both exo- and endogenous) change. Most of the exogenous R&D comes from government, whilst the firms themselves spend a significant percentage of their annual revenues on endogenous R&D.

Current technological research is centering around titanium and various compounds, including silicon carbide, silicon nitrite and carbon fibre, of layered composites for structural materials, engine design, and components.

The issue of transfer of technology and research concerning the civil aerospace industry is discussed by Keith Hayward, 1988. In his book, he addresses the issues of technology transfers and uses Airbus Industrie as a successful example. During 1991 exciting new possibilities have become possible with the demise of the Eastern bloc regimes, with several recent articles in the Wall Street Journal referring to collaborative ventures with Russia by Rolls Royce, McDonnell Douglas and Boeing.

Technology transfers are often used to overcome financial problems associated with innovating new aircraft models, with cooperative research projects, or production techniques. These transfers involve the bilateral transfer of technology in return for a fee, royalty or some other form of renumeration, or long-term working relationship, contract or risk-sharing partnership. The conduits normally used for technology transfer are:

- Interfirm co-production agreements, either fully-integrated whereby each participant is given responsibility for specific parts,

or where prime authority is given to a lead firm but the other participants manufacture the same part.

- Provision of licence-production agreements, usually reduced to assembly and minimum fabrication of sub-assemblies built in the country of origin and imported into the licensee's premises.

- Operation of subsidiary companies established to utilise R&D efforts of the parent firm, often acting as a base to transfer technologies from advanced industrialised countries to newly industrialised countries.

A new transfer method, made possible by more widespread use of computer aided design and manufacturing equipment (CAD/CAM) in manufacturing, transfers technology through computer programmes. This method of technology transfer will continue to grow as more companies acquire the CNC machines and expertise in operating them, but do not have the in-house programming expertise to write the computer instructions necessary for their functioning. In an interesting illustration of this type of transfer, one of the interviewed metal engineering component suppliers is developing a very lucrative market throughout Britain by writing and providing CNC programmes. Because it is using CAD/CAM equipment in-house and has developed programming expertise, this firm is able to market that expertise on a scale that soon may account for over twenty percent of its total annual turnover.

7.0 CHAPTER CONCLUSION

This chapter discusses the historical perspectives of the civil aerospace industry as it evolved from the military aspects of the industry. This evolution was explored from both British and the American viewpoints, including the implications of governmental actions upon the fledgling civil industry through historical and modern-day interventions by governments.

The multi-faceted aspects of civil aerospace are discussed along with the salient features that identify civil aerospace from other industries. The truly global features of the industry, from its worldwide customer base, global suppliers, and assembly operations continually emphasizes the need for internationalisation of the players within the industry. This internationalisation theme permeates the entire concepts addressed in chapters five and six, which respectively address the major assembler and its component suppliers. Much of the literature search in chapter two followed this international theme also.

The major assemblers are characterised as designers, financiers, assemblers and marketeers operating under the constraints of global competition and changing governmental ramifications.

The amended definition of symbiotic changing relationships is reinforced by transaction cost analyses, considerations of physiological dependency, Japanization tendencies and various behavioural patterns of the participants. The strategic environment faced by management is partially explained by Porter's five competitive forces and requires use of strategic planning techniques. The industry factors affecting symbiosis includes current markets, component suppliers, locational aspects, technology and research, and governmental influences. In summary, the purpose of this chapter is to set the stage for mutual changes that may be symbiotic in nature and beneficial to all participants.

CHAPTER FIVE INDEX - **BRITISH AEROSPACE AND PRESTWICK CIVIL AIRLINES' DIVISION**

CHAPTER FIVE - BRITISH AEROSPACE AND PRESTWICK CIVIL AIRLINES' DIVISION

1.0 INTRODUCTION

This chapter describes the current operating environment of the Civil Airlines Division of BAe, Prestwick, hereafter referred to as Prestwick; the exogenous and endogenous factors which are driving Prestwick's management; and the changes Prestwick is making in production, procurement, quality control, and administrative support systems.

This description starts with an overview of BAe, thence a capsule history of the civil airline division, and concludes by focusing on Prestwick's management, changing environment and need for small and medium sized component suppliers.

2.0 BRITISH AEROSPACE, PLC.

2.1 Summary of BAe, Plc.

The following data about BAe, Plc. is paraphrased (with permission) from the British Aerospace publication - "The Facts," September 1990:

Table One - Principal Business Activities of BAe, Plc.

Manufacturing:	Services Provided:
Civil aircraft	Pilot training
Military aircraft	Air combat training
Guided weapons systems	Building
Electronic warfare equipment	Civil and marine engineering
Armoured tracked vehicles	Defence forces support services
Communications satellites	Commercial communication services
Passenger cars and vans	Dredging
Wind turbines	Property development

British Aerospace, Plc. (BAe, Plc.) is one of Britain's largest manufacturing organisations. Its products and services span the civil and military aircraft, aerospace, and automotive industries; Royal Ordnance industry; major civil and marine engineering projects and services, and property development. It has extensive facilities for military and civilian aircraft crew training; the civil pilot training is located at Prestwick.

As of September, 1990, BAe, Plc:

- employs over 125,600 people within Britain and satellite offices worldwide.
- currently is UK's largest exporter of manufactured goods, trading with 150 countries.
- commercial aircraft trading is approximately fifteen percent of the total annual turnover.

An operating summary of BAE, Plc follows, all amounts shown are in million £'s:

	1990	1989	1988
Total Turnover	£10,540	£9,085	£5,706
Commercial Aircraft Sales	£1,560	£1,395	£998
Export % of sales	86%	86%	83%
Trading Profit (Comm AC)	£35	£15	£(38)
Commercial A/C Financing		£307	£215
Order Book		£3,506	£1,722
Commercial A/C # of employees	25,500	23,600	23,500

It should be noted that sales have increased one hundred fifty-six percent from 1988 through 1990, while employment has only increased eight and one-half percent. The differences in percentage change indicates how BAe is handling growth by increasing the amount of out-sourcing to component suppliers, and not adding permanent staff. This observation, with its important implications to the SME component suppliers, is discussed throughout this dissertation. This method of controlling growth by using

component suppliers is an important explanation of increasing plant capacity, e.g., building the ATP model, without increasing significantly the workforce.

Editorial note: during a post-research conversation with management in December, 1992, it was disclosed that the ATP (Advanced Turboprop aircraft) build is being moved to Prestwick. Prestwick management does not expect employment to significantly increase because of this increased work load, again signifying the reliance upon outside sub-contractors and component suppliers.

2.2 Description of the Civil Aircraft Division

The civil aircraft division of BAe Plc., has three operating divisions - Airbus division, Airlines division, and Corporate Aircraft Division.

(1) The Airbus division primarily designs, engineers, and builds the wings for all civil aircraft models of Airbus Industrie at Broughton (Chester) and Filton.

(2) Airlines division builds the BAe 146, four-engine jet airliner at Hatfield and Woodford; BAe ATP, advanced turboprop two-engine airliner at Woodford; and the Jetstream 31 and 41, 19 and 29 seat airliners, at Prestwick.

(3) Corporate Aircraft division builds the BAe 125-800 twin engine business jet at Broughton (Chester); and the BAe 1000 longer range business jet at Broughton (Chester).

A capsule history of the formation of the civil aircraft division of BAe reveals that on:

April 1977 - British Aerospace, (BAe) formed as a nationalised corporation merging British Aircraft Corporation, Hawker Sidderly Aviation, Hawker Sidderly Dynamics and Scottish Aviation.

Note - British Aircraft Corporation (BAC) was formed in 1959 with the merger of English Electric Aviation, Vickers Armstrong Aviation, Hunting, and Bristol Aircraft Companies.

January-February, 1981 - British Aerospace, Plc., formed as a public limited company with the UK government selling 51.7 percent of its shares to the public.

May 1985 - UK government sold its remaining shares, keeping a special 1£ share to ensure company continues indefinitely under UK control.

August 1989 - limit on foreign shareholding raised to 29.5 percent, thus attracting more foreign ownership.

2.3 Civil Airlines Division, Prestwick

BAe Commercial Aircraft, Civil Airlines Division, Prestwick, builds the Jetstream 31, Super 31 and Jetstream 41 aircraft on a 62 acre site at Prestwick International Airport, Scotland. In addition, complete wing fabrications, tail surfaces, components and special products are manufactured by Prestwick for other BAe divisions and for non-BAe, aerospace manufacturers.

Current workforce (1989-90) is approximately 2,000 personnel, with significant inputs from independent component and parts suppliers. Over 450 suppliers are currently utilised for the Jetstream 31 programme. Through single sourcing implementation, the planned outside supplier list for the Jetstream 41 build is less than 250.

The 1991 build programme is 25 Jetstream 31 models, certification of the prototype Jetstream 41 model, and additional aerostructures for other divisions and aerospace firms. Historically, the build programme has

fluctuated ten percent under normal conditions; under unexpected circumstances it may vary considerably more.

The BAe 'Flying College' is also located at Prestwick and is a full-services training academy for airline pilots. It is a separate division from the manufacturing facility.

The Prestwick civil airlines division meets the research criteria established for this dissertation because:

- they are a complete assembler of several aircraft models;
- they manufacture sub-structures for other BAe divisions as well as unrelated companies worldwide;
- they have autonomous managerial control over all functions of their operations, except for marketing, which is centralised at the corporate home office; capital expenditures are limited to a pre-determined level each year, as determined by corporate management and board action;
- Prestwick maintains its own component and sub-assembly procurement list. Each division of BAe, in addition to its regular duties, completes the required annual quality audits of all BAe suppliers located within their geographical region, regardless whether or not they are a component supplier to that particular division.[51] Interviews with quality assurance personnel indicated much of their compliance auditing time is spent with suppliers to other divisions of BAe. However, they quickly pointed out that other divisions perform a sizeable amount of quality compliance auditing for the benefit of Prestwick also.

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51. There is discussion amongst the big three aerospace manufacturers (BAe, Rolls Royce and Westland) and the Civil Aviation Authority (CAA) to jointly administer one quality audit per site per annum in lieu of the individual audits currently undertaken. The suppliers expressed support for this consolidation as it would reduce their non-productive time spent with the manufacturers by at least sixty-six percent.

The operations manager, Mr. D. G. Williams, stated to the researcher that Prestwick is often chosen as a procedural test-site by BAe because it is a complete micro-aerospace firm. The changes and their ultimate effects are easier to observe in a small enclosed environment as exemplified by Prestwick. This gives BAe the opportunity to observe the effects of their decisions before they are made company wide policy. (Interview, 24 April, 1990.)

2.4 Setting the stage: Observed Exogenous and Endogenous Management Drivers at Prestwick

The question naturally arises as to what 'drives' the management of Prestwick to make changes, and develop changing symbiotic relationships with its component suppliers.

The normal, and expected, operational management considerations of competitive pressures, changing customer needs and demands, changing technology, corporate headquarter's requirements, and striving for success are pertinent to Prestwick's environment and were observed by the researcher.

In addition to the expected drivers discussed above, the researcher observed other factors involved as management drivers. These observations included:

- development of a niche market in propeller driven commuter aircraft for regional airlines; many smaller airframe manufacturers have entered the corporate jet market, however only a few manufacturers are building 19 to 29 seat propeller-driven commuter aircraft.

- exploitation of a proven aircraft design, accepted world-wide as evidenced by its past and present sales levels; production managers and quality assurance personnel described how reliable and

relatively simple these aircraft are to maintain and operate. The Jetstream has a reputation for economical operating costs and reliable operations according to operations personnel interviewed. These opinions were seconded by an opportunistic interview with an American CEO of a large regional airline familiar with the Jetstream. He was particularly complementary of the Jetstreams' quality and endurance.

- pride and expectations of a skilled Scottish labour resource that wants to excel and is willing to change. The researcher was allowed reasonable access to floor personnel and they expressed their feelings of being part of a skilled workforce building a quality product. Several production personnel had been with Prestwick longer than twenty years and were obviously proud of their skills and working environment. Personnel in a position to do so were working towards their certification, so that they could 'ave the stamp', which seems to imply a measure of highest quality work to them.

- long-standing tradition of meeting the needs of its customers, which includes repair and servicing of earlier aircraft models no longer in production, (including models built during the 1940's); While making several walk-throughs of the production facilities the researcher observed several older aircraft being worked on or being serviced. When queried, the mechanics explained that any aircraft built by Prestwick, regardless of age, would be serviced by Prestwick. Although this is not an official policy of Prestwick's management, it appears to be true in practice.

- feeling of a special 'elite' corporate division, which is often used as a test site for implementing corporate wide production, procurement and administrative policies or procedures. Because Prestwick is a complete assembler, in effect a 'miniature airframe company', it is an ideal test location for new corporate policies or procedures.

- upper management's willingness to change traditional relationships and procedures. This attitude includes the desire to implement closer partnership relationships with their supplier base, modernise their assembly and manufacturing procedures, implement management information systems and explore non-traditional procedures. Examples of these attitudes are using an outside bonded warehouse company on-site for receipt and issuance of parts and components, open-bin stockage, cellular manufacturing and JIT procurement, delivery and assembly procedures. The attending management support systems, e.g. managerial accounting, are also being reviewed and updated as necessary.

These management and workforce attitudes have been noticed and encouraged by corporate headquarters, as witnessed by a letter from Mr Masefield to the researcher:

"...within our sites none are making more rapid advance in respect of changes in production methods including JIT, purchasing procedures, quality programmes and risk sharing than our Prestwick site...".[52]

2.5 Prestwick's Mission Statement

Prestwick's stated mission, strategy and direction is:

"There exist clearly defined statements of strategic direction and purpose for our business.

Communication and understanding of the Prestwick mission, strategy and direction is company wide.

Changes are implemented continually to develop our people, processes, products and services with the goal of continual satisfaction of the expectations and agreed requirements of our internal and external customers.

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52. Letter from C.B.G. Masefield, Managing Director, British Aerospace (Commercial Aircraft) Limited, Airlines Division, Hatfield, dated 16 March, 1990, to the researcher.

All practical quality-related initiatives are encouraged and facilitated through demonstrable senior management commitment and involvement.

Suppliers and sub-contractors to Prestwick are encouraged to employ values similar to those of Prestwick."[53]

Senior management at Prestwick has issued a written policy statement regarding a corporate culture of quality and development of partnership relationships with its suppliers and staff. This goal was formalised in 1989 and has continued until the present time.

The mission statement of senior Prestwick management emphasizes the importance of encouraging suppliers and sub-contractors to employ values similar to what Prestwick is implementing. This mission statement, if implemented, can influence the perception by SME management of influence over their changes by Prestwick.

The implementation of management's plan is best illustrated by several examples described below:

(1) Cost reduction programme

The cost reduction programme is part of a flexibility-in-build programme and JIT implementation. This programme includes commonalty of parts amongst several models, use of standard parts to replace special design, and fewer numbers of parts in the total build. Suppliers are asked for their inputs into the pre-build design process, parts simplification, and substitution of less expensive standard components, when appropriate, for the designed part.

(2) Sourcing relationships

The development of sourcing relationships is part of the culture of quality and two-way communications. Prestwick's intent is to engender a feeling of mutual beneficiality or partnership through changing their sourcing

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53. Pamphlet, 'Total Quality Culture', Prestwick Airlines Division, British Aerospace, p. 15.

methodology and relationships. Management's emphasis is on building long-term relationships, using open-ended contracts, implementing plant visits and other communication methods with their component suppliers.

Examples of improving sourcing relationships are utilisation of a twelve-month projected build programme[54] that is provided to selected vendors, and provisions for communicating known or potential changes in a timely manner to all concerned parties. Asking specific vendors to participate in the front-end development costs of the Jetstream 41 programme was calculated to improve sourcing relationships as well as raise risk capital.

An example of developing a long-term relationship is where vendors are encouraged to recover their design and R&D costs, if any, over the projected total-build of the aircraft in lieu of recovery in the early build-sets. This encourages the suppliers to lower their initial prices through amortization of design and development costs over a longer build, and gives the suppliers some assurance that they are involved for a longer term. Longer contracts also allow the suppliers to arrange new equipment financing using the contract as collateral.

(3) Single or limited sourcing

Single sourcing is part of the JIT manufacturing and procurement philosophy being implemented by Prestwick. The Jetstream 41 build programme is being used to decrease the total number of vendors to less than 250. Eighty percent of the bought-in parts for the Jetstream 41 programme are purchased from 205 vendors; this receives the major

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54. This schedule is termed 'build programme' and projects the next twelve months of aircraft and assemblies to be built at Prestwick in a 'build-window', on a forward-rolling basis. This computerised schedule describes in detail the quantities of materials, parts, and components needed on specific dates to complete the designated build for the contracted delivery dates.

attention of the purchasing system. This is a reduction of fifty percent from over four hundred vendors for eighty percent of the parts in the Jetstream 31 programme.

(4) Vendor responsibilities

Design responsibility has been incorporated into the Jetstream 41 build as part of the flexibility in design programme. Prestwick has given limited authority for final design and R&D responsibility to qualified component suppliers possessing this capability. This change agrees with Burt (1989), who observed that manufacturers must require that their suppliers be capable of mastering new components and also be capable of design capabilities.

To be meet this new requirement, some suppliers are utilising the services of certified independent design and engineering shops. These professional engineers assist the SMEs in preparing their bids and do the design work for the actual components; a new tier of professional services not extensively used in the past is therefore now employed. One engineering company interviewed has developed its computer-aided-design and manufacturing (CAD/CAM) expertise to such an extent that it offers design engineering and computer programming to outside firms.

Another vendor responsibility given on a selected basis is complete contract administration for a major component. A primary contractor is designated and given administrative responsibility for necessary sub-contracting parts or processes which they do not provide and ultimately delivering a completed unit to Prestwick. None of the respondents to this research had been assigned this responsibility as of the time of interviews.

(5) Manufacturing changes

Just-in-time (JIT) manufacturing methods encompass the flexibility of modular construction as well as JIT manufacturing procedures; termed

'assembly cell manufacturing' at Prestwick. In addition to modular construction techniques, this procedure also places quality control authority on the assembly-cell for its particular function. This quality control method allows rapid error detection and determination of the cause of errors. Another advantage of this type of assembly is that workers can perform multiple tasks while building their designated portion of the aircraft. This capability improves the flow of the aircraft through the assembly process and enhances the workers skills. The assembly-cell production method utilises a visible open-bin inventory system, using a pull system for parts and components similar to the Toyota 'kanban' method.

(6) Administrative support system changes

One example of an administrative system change is the vendor payment procedure. Prestwick is attempting to lengthen vendor payment terms to 120 - 180 days for most components. The intent of this change is to time the vendor payments on components until receipt of purchaser's payment for the aircraft, or until the aircraft is completed, whichever is earlier. As discussed in chapter six, this change has met with extensive resistance by the component suppliers. The SMEs believe that this has caused an increase in component cost because they must include a cost of external financing in their pricing. Prestwick's management anticipated this additional cost, but believes that, because of competitive pressure, the overall rise in cost is less than the cost of money to Prestwick from either external or internal sources.

(7) Surge capacity

The provision for vendor surge capacity is part of the two-way communication goal and JIT manufacturing concepts. Approximately ten percent of the vendors are designated surge capacity suppliers. A surge capacity vendor agrees to respond to as much as a fifty percent increase in

its contract within an agreed time period to meet non-scheduled increases in production rates. The vendors consider this designation a mixed blessing. The obvious advantage to being designated a surge capacity vendor is being designated prime contractor for that particular component. The offset to the SME is that certain production-capacity 'set-asides' must be allowed for rush orders.

(8) Vendor rating

Prestwick has begun rating vendors for quality and on-time delivery performance. This is part of the culture of quality and JIT manufacturing implementation by Prestwick.

The vendors are accustomed to annual quality control inspections for certification by governmental agencies and aerospace companies. The new, more comprehensive system rates on-time delivery, number of product defects, responsiveness to change and other performance factors has affected some vendors more than others. As discussed previously, this rating procedure has influenced similar changes being undertaken at the component supplier level and has been implemented as a mirror-image change whereby the SMEs are rating their suppliers.

(9) Total commercial package

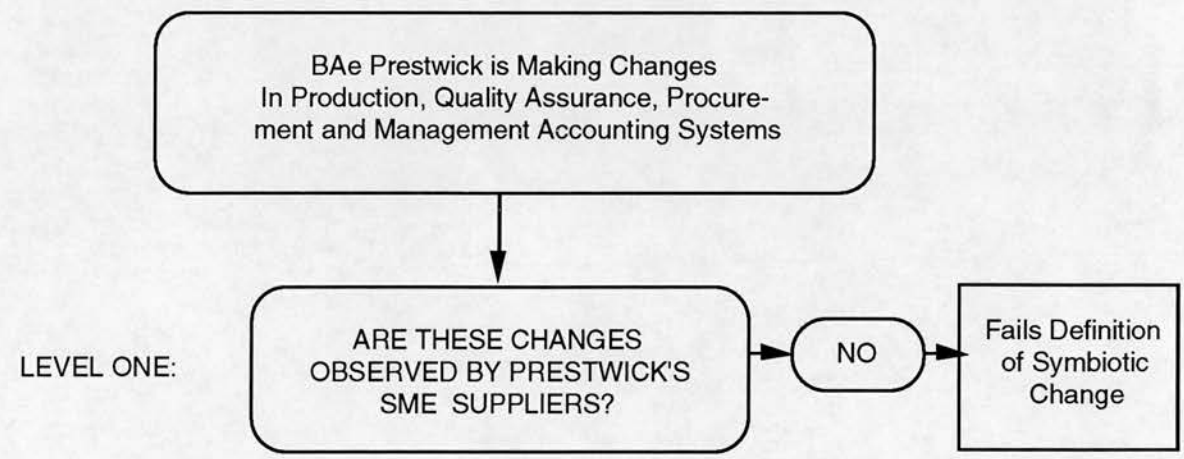
The term, 'total commercial package' includes the cost of the item, delivery, quality assurance, and financial impact of defects. In some cases it may include research and development and design of the component. Change in purchasing methodology to a 'total commercial package' is part of the two-way flexibility concept and JIT manufacturing. For major assemblies and engines, this includes risk and launch-sharing financial contributions, free build-sets for prototype work, extended product warranties, and price validity through the end of the following financial year.

For all other components, this methodology also includes total delivered quality, on-time delivery, just-in-time delivery, terms, and price considerations. The purchasing changes have affected, with a smaller-scale version, the purchasing methods of the component suppliers. The SMEs are negotiating with their suppliers for on-time delivery, quality assurance, and payment terms, whenever possible.[55]

3.0 PRESTWICK CIVIL AIRLINES DIVISION OF BAe

3.1 Changes at Prestwick

Part of Figure One, Chapter One, which begins with the importance of determining change at Prestwick and thence establishing that the SMEs observed these changes is included below. This segment of Figure One illustrates the necessity to establish the existence of change at Prestwick and search to see if these changes are visible to their component suppliers.



Personal interviews with senior management at Prestwick indicate that they are implementing several strategic changes. The areas

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55. Section three discusses the problems the smaller vendors have with suppliers who are many-fold larger than they, with an apparent lack of clout in negotiating terms and delivery. For example, several vendors state that their suppliers insist on their taking standard order quantities, which may be six months' stockage for a small component supplier.

undergoing change include just-in-time production and delivery methods, development of a culture of quality, assembly cell manufacturing, purchasing methodology, and physical stock reductions. Management states that these changes have been initiated within the past three years, and that many, if not all, are currently in-process of being implemented.

Management's perceptions were verified by subsequent interviews with subordinates, confirming that the changes are being implemented downstream internally. This verification was triangulated by interviews with suppliers who observed the existence of change at Prestwick in the specified areas, downstream, externally. In addition, most of the changes were observed by the researcher during walk-throughs or during interviews with personnel implementing the changes, further triangulating the answers.

During several walk-throughs of the Prestwick facility by the researcher, visual and oral observations confirmed changes in production methods, parts handling, quality administration, and purchasing procedures were being undertaken. These observations confirmed earlier discussions with several different levels of management, and verified the published pamphlets given to the researcher that stated changes were in-process concerning these operational areas.

The researcher was given reasonable unrestricted access to production workers and engaged in frank discussions with them. These discussions often verified procedural changes mentioned by several layers of management. For example, several workers showed with pride Prestwick's implementation of cellular manufacturing, by utilisation of 'assembly cells'. These assembly cells bring all of the correct components, materials and parts into a single assembly area, where the skills of the workers can then complete that particular phase of assembly. Each aircraft may remain at an assembly cell area for a lengthy period of time, before

moving further down the 'line'. Aircraft under construction are not frequently moved because of the logistics involved and amount of space occupied by each aircraft, thus forming a natural assembly cell.

Another change the production workers welcomed was training in quality assurance. It is considered a prestigious accomplishment to be trained for and receive the authority to have a CAA issued quality stamp. This quality stamp, or seal, enables the bearer to inspect and certify as air-worthy the particular part or assembly. That seal is numbered and can be traced back to the bearer, who is held responsible for its air-worthiness. This change is part of the quality culture that upper management is trying to instill at Prestwick. They (upper management) believe that this will improve over-all quality, reduce the number of internal quality control inspections, and increase work-force morale. The implementation of this change appears to be achieving the desired results.

Single aircraft through-put, or cycle time, from signed order to aircraft delivery has been reduced from ninety weeks in 1988 to forty-one weeks in 1991. Batch sizes have been reduced from thirty aircraft to ten per build-lot. Purchasing and stockage personnel welcomed this change as a significant move towards reducing the size of inventories at Prestwick. Several stores personnel commented at how surprised they were during the first major down-sizing of stocks about how many extra items were 'lying about' the site.

Some of the purchasing personnel were reluctant about the ultimate effect downsizing of inventories would have on prices, as they believed it was just pushing inventories downstream upon their suppliers. This observation was supported by interviews with suppliers, many of whom felt that they were now the stockists for BAe.

Production personnel at Prestwick were more critical about the reduction of buildsets and inventory stockage levels, distrustful of not having parts as needed. Several production personnel and line managers stated that they did not trust British suppliers sufficiently to implement completely JIT and reduce 'buffer' inventories below minimum 'safety' amounts. Their primary reason was fear of work stoppages at their suppliers or haulers, and other union activities disruptive to production schedules. (Researcher's note: it is ironic that the only work stoppage that occurred during 1989 and 1990 happened at BAe. None of the respondent suppliers had a union stoppage or labour experience disruptive to Prestwick. In fact, the prolonged strike at BAe adversely affected many of the suppliers, causing them scheduling, procurement and financial, especially cash-flow, problems.)

3.2 Changing Symbiotic Relationships

A changing symbiotic relationship 'attitude' by Prestwick's management was detected in personal interviews and in published policy statements. Management's desired relationship with component and material suppliers is four-fold:

(1) One goal is two-way flexibility in build and design programmes between Prestwick and its component suppliers. The management intent is to have defined flexibility in the build programme, to allow for adjustments to fluctuating market conditions. This build flexibility must, of course, include a willingness to change by both parties, even during a recession or when adjusting to the consequences of slower build-periods. Upper management desires the flexibility of making timely changes to the build schedule, but through proper communications blunting any negative impacts upon the SMEs. The SMEs interpreted this objective as Prestwick

being the dominating force; changes would originate from Prestwick and be communicated to the component suppliers.

This build flexibility highlights the opposing opinions of several Prestwick production managers, who believe it is more economical to build in uniform larger batches, even if some of the build are green-tails (unsold aircraft). The production personnel believe this smooths the build process and makes it easier for the suppliers to uniformly provide defect-free parts. This production personnel belief is in opposition to the stated Prestwick management objective of utilising JIT production methods and building to actual sales.

(2) A second goal is two-way communications between Prestwick and its component suppliers. This relationship is an essential element to achieve goal number one above and has been discussed there. The objective is to establish an atmosphere of mutual trust so that each party communicates problems and successes to the other party.

Management envisages two-way communications occurring by keeping the other party fully informed through personal contacts, briefings, bulletins and other communication methods. Several interviews with production and materials management personnel indicated this is difficult to implement, particularly because of engineering change orders. The engineering department is often targeted as the guilty party in delaying key design changes until absolutely the last minute, then production has to work long hours at overtime rates to meet the build schedule. (This is a classic production vs. engineering conflict, common with manufacturing entities of other types.) Often the component suppliers agreed with production personnel that engineering takes an inordinate amount of time producing the necessary drawings and specifications for changes that are urgently needed.

(3) A third management goal is to develop a corporate culture (philosophy) of quality - the goal is to have the product delivered on-time with quality right the first time. The stated objective is to convince every employee and supplier to become quality-conscious and not to allow defects past their workstation. This change in 'culture of quality' is being implemented from the top down. Senior managers are sent to two two-week management courses at international Universities. Middle managers are given continuous on-site training programmes, and the work force are encouraged to upgrade their skills.

To achieve this quality goal, Prestwick is seeking more 'BAe approved' and 'Civil Aviation Administration (CAA) certified suppliers. Prestwick is trying to accomplish this goal by assisting suppliers with their certification via on-site visits by special assistance teams and practice inspections. Internally, Prestwick is training more of its line staff to become CAA certified with a quality 'stamp', issued by CAA. The CAA stamp is used to certify air-worthiness of a part or component personally inspected by the stamp owner. This stamping process is an essential part of certifying an airplane air-worthy, and provides traceability to parts or systems in case of crash or other failures.

These changes agree with W. Edwards Deming's argument that to achieve quality the culture of quality must come from the top down. Prestwick is trying to implement their culture of quality from the top down, as evidenced from their written and verbal communications.

(4) The fourth goal of Prestwick's management is to have component suppliers understand and implement just-in-time (JIT) manufacturing techniques, quality control methods and just-in-time delivery procedures. As a result of observing these procedures at Prestwick, many

component suppliers were encouraged to change by implementing appropriate mirror-image procedures at their locations.

In practice, these goals are being communicated to the external suppliers and the internal staff and production personnel at Prestwick. Internally, the essence of the goals are reaching the shop floor and are being implemented by middle management.

These four-fold relationship changes reflect a major strategic change at Prestwick, and a conscious effort by Prestwick's management to improve its vendor and internal workforce relationships.

3.3 Need for Component Suppliers - Purchase of Components

The typical civil aerospace buy-in of components vs. in-house manufacturing is 60/40, according to BAe and Boeing publications. Interviews with Prestwick's purchasing and quality inspection personnel reveals that approximately sixty-three percent of the total cost of the parts and components used at Prestwick are bought-in from outside suppliers. As shown in the introductory summary table, BAe is able to significantly expand sales without increasing employment in the same ratio by utilising outside contractors.

Of the total bought-in amount, approximately sixty percent is imported from other countries, and the remainder is purchased from British suppliers. Therefore, approximately twenty-five percent (63% X 40%) of the total build at Prestwick is purchased from British component suppliers; this supplier base is the focus of this research.[56] Political ramifications often impose where components are purchased; several airline customers require that a

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56. This focus does not imply that foreign suppliers are treated differently. The intent is to place into perspective the size of the British component suppliers utilised by BAe Prestwick and dealt with in this research.

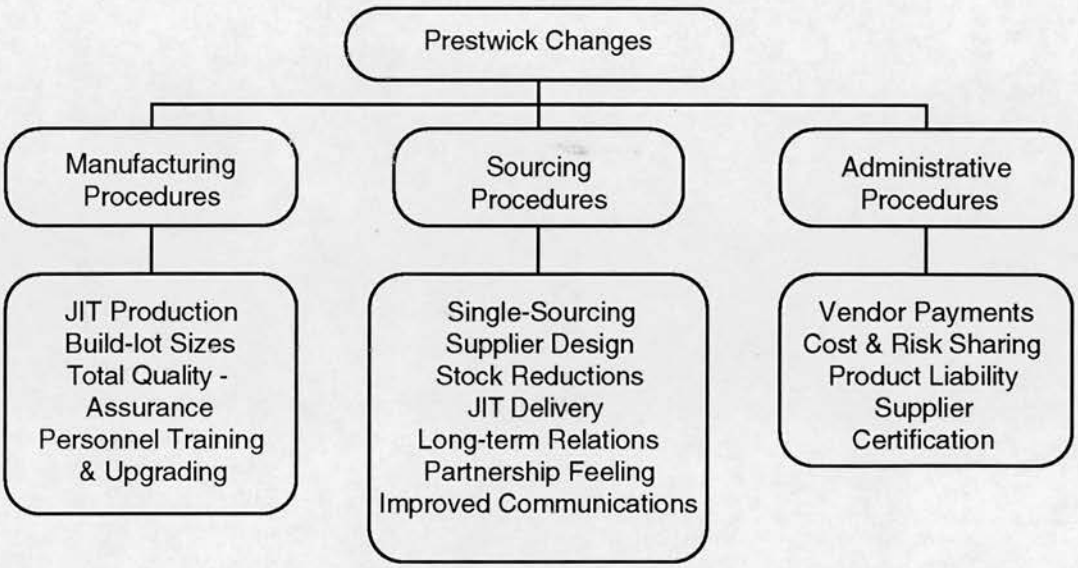
certain percentage of the build must be purchased from the customer's home country.

4.0 RESEARCH FINDINGS - CHANGES MADE BY PRESTWICK

In response to the changing requirements of the market and related internal pressures from BAe, Prestwick management began a series of reforms beginning in 1987, which are outlined below. To clarify the analysis, these improvements have been analyzed under three major headings, manufacturing procedures, sourcing procedures, and administrative procedures. Each of these prime categories has been broken down into separate sub-headings as shown on the diagram below.

The detailed findings are a synthesis and analysis of interviews conducted with the following managerial positions: general, operations, production scheduling, manufacturing, procurement, quality assurance, and facilities. (The specific semistructured questionnaire administered to Prestwick's executives is included as Appendix B.) In addition, the interviewer was permitted to discuss different aspects of the changes taking place in Prestwick's operations with individual shop floor operators and various supervisors. Several of these open-ended discussions were conducted with small groups of employees informally at lunch in the canteen, with individuals contributing at will to the conversation about subjects of interest to them. As mentioned in the methodology chapter, this richness of information gathered is possible because of the semi-structured format chosen to gather the research data. The walk-throughs of the assembly areas were beneficial because not only could verification be made of previous statements, but new areas of inquiry could be opportunistically determined from visual observations made during the walk through.

Figure One - Prestwick Changes



The interviewer was permitted reasonable access to the Prestwick facilities and so was able to observe elements of the changes discussed below. In a number of key instances, the changes were confirmed (triangulated) by the SME executives who were interviewed later in the programme. Reference will be made to their comments where it is felt that such comments will strengthen the evidence that Prestwick's reforms were being implemented and not simply a future strategic goal currently in the planning stage.

4.1 Manufacturing Procedures

Prestwick is changing towards just-in-time (JIT) manufacturing and production procedures including smaller build sets, smaller total inventories, fewer buffer inventories at manufacturing cells, build to confirmed sales only, cellular work stations, and workers' skill improvement, certification and empowerment.

4.1.1 JIT production methods

Prestwick management has set an overall goal of endorsing JIT manufacturing and production procedures, applying it to their needs as appropriate. For example, the JIT goal of building one unit at a time is not currently deemed desirable for aircraft manufacturing, however Prestwick has decreased the build-sets from thirty to ten aircraft. In reality however, each aircraft is a unit of one because it is built to unique customer specifications. (Information obtained from interviews with operations and production managers, and company literature.)

Cellular manufacturing techniques are utilised whenever possible, with favourable comments received from production line personnel. This technique is particularly applicable to buildup of components and sub-assemblies for later insertion into the aircraft. Line personnel like this procedure because it allows them to perform several jobs instead of one routine function. Once assembly begins on the aircraft, it can easily be compared to a cellular manufacturing 'assembly cell'. The aircraft is infrequently moved 'down-the-line', thus it is a manufacturing cell for a designated period of time at each location during assembly.

A visible bin system of stocking parts for the next days work is also utilised, similar to the Toyota kanban system. The visible bins allow the stock personnel to keep the flow of needed parts and components to the production personnel, without the formality of the kanban cards. Because the aircraft are only built to a delivery schedule for sold aircraft, and enabled by sophisticated computer materials requirement programmes (MRP II), 'backflushing' of parts can be utilised to keep the visible bins properly stocked. (Above information obtained from interviews with production and production scheduling managers.)

4.1.2 Build-set (lot) sizes

Prestwick reduced its lot size per 'build-set' from thirty aircraft to ten. This essentially means that all components, sub-assemblies, materials and parts arrive in multiples needed for ten aircraft. (Except major cost items, e.g., engines, landing gear, etc., which may be delivered in smaller quantities.) The object of reducing the build-set is twofold: one, to decrease the number of change orders occurring during the build, all non-essential changes are deferred until the next build-set; and, second, is to reduce inventories of all types. This reduction of build lot sizes increases assembly flexibility, reduces stockage of parts, supplies and components to just the build-set in progress, improves cash flow by not having to pay for purchased items until needed for assembly, and frees up badly needed assembly space in the factory. (Operations and procurement managers interviews.)

4.1.3 Total quality assurance

Senior management at Prestwick has undertaken a basic attitude change in developing a 'quality of culture' amongst the managerial staff, supervisory staff, inspection and production employees. Management believes a commitment to continual quality improvement is necessary to implement successfully JIT manufacturing techniques. (Operations, production and quality assurance managers' interviews, company brochure.)

Although high quality standards have been a consistent aerospace requirement, Prestwick has focused on changing responsibility for achieving these standards (certification of workers and suppliers) and defect free delivery of inputs. (Both of these changes focus on commensality and mutual beneficiality, which will be more fully discussed later.) These methodology changes were visible to the SMEs and lead to symbiotic change - triangulation or verification of change.

The culture of quality change empowers Prestwick's line personnel to undertake continuing inspection of their work, inspection of incoming pieces, and inspection for conformity to design and specification before installation or further processing. Simultaneously, Prestwick is trying to educate its suppliers to strive for these goals and deliver defect free components.

4.1.4 Personnel training and upgrading

Qualified line personnel are being encouraged through formal and on-the-job training to upgrade their skills and apply for CAA certification. Once this certification is achieved, they are issued a numbered stamp with which they certify that inspected parts or components meet air-worthiness requirements. This certification not only enhances the worker's capabilities and value to Prestwick, but also reduces the number of quality assurance inspections by the quality control department.

In addition to personnel upgrading, internal lines of communication are being opened to keep all personnel informed about current business events within the division and BAe. This internal communication involves training information that is more general and company wide, or about specific subjects like statistics that can be used by a wide range of personnel. These communications include daily video messages broadcast in the dining hall and other designated areas; personnel are given free time during their shift to watch these messages. Company newsletters are distributed periodically that are informative and of high quality, highlighting recent personnel events, aerospace business news and production data.

4.2 Sourcing Procedures

The second major area of change at Prestwick is the sourcing and procurement area of operations being implemented specifically for the Jetstream 41 programme. Changes in this area include single ('limited' is

more accurate) sourcing of eighty percent of the Jetstream 41 components as compared to a negligible amount of single-sourcing for the Jetstream 31; supplier-design of some major assemblies; reduction of total inventories; JIT delivery; long-term buying relationships; long-term partnership relationships with suppliers; and improved communications with suppliers.

4.2.1 Single-sourcing

The introduction of the Jetstream 41 is being used as the catalyst for implementing single or limited sourcing procedures at Prestwick. The stated goal is to decrease the number of suppliers from more than 450 in the Jetstream 31 programme to less than 250 suppliers for the 41 programme. The purpose of this goal is to simplify paperwork, obtain lower delivered prices, improve quality, and develop a feeling of partnership between the entities. This goal is being implemented by certifying suppliers who meet the quality, delivery and price requirements of Prestwick. This goal, as set by top management, is meeting quiet internal resistance; there appears to be a distrust of becoming dependent upon one supplier amongst Prestwick's buyers. (This resistance was also found in the early pilot test conducted within the electronics industry, it appears to common amongst buyers who have been 'burned' by a single source supplier failing to properly perform.)

4.2.2 Supplier design responsibility

Prestwick is implementing a policy of delegating as much component design responsibility as practical under current conditions. Their stated policy is to assign design, sub-contract, and build responsibility to certified suppliers possessing these capabilities. The obvious advantage of this policy to Prestwick is that it allows for capacity expansion without increasing their administrative overheads. A secondary advantage is that it builds closer 'partnership' relationships with the selected design suppliers because they are involved in the build from the outset.

4.2.3 Reduction in inventories

Prestwick has been aggressively reducing their inventories for several years. The first effort was simply reduce the amount of stocks on hand by not buying-in replacements. This plan 'flushed a surprising amount of bits and pieces out of various parts of the facility' according to one material handling manager. Subsequent strategies are consistent with JIT production methods by requiring suppliers to deliver smaller quantities more frequently per the build schedule. Prestwick recognizes that for this plan to succeed the delivered quality must be consistently high; they are implementing a 'zero-defects goal' for their suppliers. Prestwick is rating their suppliers for on-time delivery, quality, and compliance with the contract specifications. Prestwick believes this will improve communication between the two entities because the component suppliers will be more open about production problems to avoid negative ratings or incurring possible penalties.

4.2.4 Long-term buying relationships

Prestwick's top management has expressed written and verbal objectives of establishing long-term relationships with suppliers. As part of establishing a longer-term relationship, Prestwick management personnel visit suppliers on average each seven months, with eighty-eight percent of the suppliers visited at least annually.[57] The primary purposes of the management personnel visits are to foster relationships and to improve communications. (See Giunipero, 1990, for corroborating research.) Prestwick encourages the managers from their suppliers to visit their facility as part of this longer-term buying relationship.

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57. However, many of these visits are technical in nature, made by engineering or production personnel. As discussed in Chapter Four, several of the SMEs complained that general management and procurement personnel do not visit them as frequently as they feel is necessary.

Another method of implementing this goal is to award long-term contracts, perhaps for the estimated build-life of the aircraft model, so that suppliers can implement long-term planning strategies. These contracts are open-ended as to the quantities needed each year, but an over-all estimate is included for the contract life. This enables their suppliers to plan finances, because they have a long-term contract to show their banker or financier for acquiring necessary operating or equipment acquisition loans.

4.2.5 Partnership development

Senior management at Prestwick stated their objective is to establish a feeling of partnership between the component suppliers and Prestwick's personnel, committing for long-term commensality. Management envisages that two-way communication is the key to this long-term objective. This partnership attitude is complimentary to the long-term relationship discussed above. The partnership concept is more expansive however, and includes strategic planning, pricing, cost-containment, and other indicators that the two entities are working closely together for their mutual commensal benefit.

The development of partnership-type relationships has been previously discussed above in the areas of single sourcing, supplier design responsibility, and buying relationships.

4.2.6 Improving communications - a summary of desired communication goals by Prestwick's senior management includes:

Management's goals

Senior management at Prestwick stated that communication and understanding of their goals and missions are a highly rated value. They also encourage suppliers and sub-contractors to employ similar values as Prestwick's in their mission statements. These top management goals are being communicated internally to Prestwick personnel through training,

brochures, and video programmes, and externally to their suppliers as part of the purchasing 'package', communications and managerial visits.

Adversarial purchasing attitudes

Elimination of the traditional adversarial buying attitudes between the major manufacturer and its suppliers is another communication objective of Prestwick's management; as expressed during interviews and in their written policy statement.

Open flow of communication

Another stated objective of Prestwick's management was keeping the suppliers informed about production schedules and changes to the build-programme. This objective is being implemented through use of a published 'build-window document', with updates regularly published. This build window schedules delivery and assembly dates of all parts and components by 'backflushing' from the scheduled finished aircraft delivery date. (Backflushing is where the necessary parts and components are determined by looking at the finished product to determine the number and delivery sequence of the build.)

4.3 Administrative Procedures

The third major area of Prestwick's operations studied as part of this research is their changes in administrative procedures. Observed changes in Prestwick's administrative procedures include vendor payment frequency, cost and risk sharing, product liability, supplier certification and internal changes in management accounting systems. Sixty-nine percent of the respondents have observed one or more procedural changes in administrative policies at Prestwick.

4.3.1 Vendor payments

The more controversial administrative change at Prestwick was the vendor payment procedure. Prestwick's management had stated that their new policy is to extend payment 120 to 180 days whenever possible, making payment more consistent with completion of the aircraft. This policy was implemented, from Prestwick's point of view, as part of the changing partnership relationships between the major and its suppliers. Prestwick's management believes that all entities are in the market-place together (commensal relationships) and each should share the financial responsibility of financing the aircraft until it is built and delivered.

4.3.2 Cost and risk sharing

When Prestwick decided to build the Jetstream 41, the key component and materials suppliers were contacted to participate in the financial burden of the research and development costs, as well as launch costs for the new aircraft. Financial participation could take several forms, e.g., contributions of cash, design work, contributions of sample components, and contributions of spares for testing. Nearly half of the total costs were raised by Prestwick in this manner; management believed the programme to be successful.

4.3.3 Changes in product liability

Prestwick is attempting to increase the product responsibility of its component suppliers by requiring them to make replacements for failures directly with the customer. In some cases this requirement extends beyond the stated warranty period of the component. This concept is compatible with the commensal relationship of building an aircraft together and meeting the market requirements as a long-term partnership.

4.3.4 Supplier certification procedures

Suppliers are required by governmental agencies and aerospace companies to be certified annually as to compliance with product safety standards. (BSA 5750, amongst others.) This procedure is cumbersome and takes a toll on a small firm's resources if they sell to several major manufacturers; often having multiple inspectors on their premises for weeks at a time. Prestwick is joining with the CAA, BAe, Rolls Royce and Westland to implement a single inspection procedure from the geographically nearest major manufacturer. These inspections will be monitored by CAA, and will have just one inspection team visit per annum. This is a mutual benefit, for the majors do not have to deploy as many teams in the field, and the component suppliers should not lose valuable work time, explaining the same information four times over.

This section establishes the fact that Prestwick is making changes in their manufacturing, quality assurance, procurement and administrative procedures. These changes were verified by discussions with Prestwick managerial personnel, company literature, visual observations by the researcher, and subsequent confirmations by the SMEs managerial personnel.

5.0 CONSEQUENCES OF CHANGES - EFFECTS UPON THE SUPPLIER NETWORK

The sections above establish that Prestwick is in the process of making changes in their manufacturing, quality assurance, purchasing and administrative systems. This section will examine these observations from several perspectives: one is an analysis of the SMEs observations of

changes at Prestwick, and the other concerns the SMEs' perceptions or impressions about these changes.

5.1 SME awareness of Prestwick's changes

The first perspective queries if the SMEs have observed, or are otherwise aware of changes at Prestwick. The importance of the SMEs observations about changes being undertaken at Prestwick rests in the concept that mutuality and beneficiality are necessary elements of symbiotic change. The commensal partners in symbiosis have common goals and objectives by definition, and the changes that each are making must reflect this commonality. Therefore, an analysis is appropriate in this section of various impressions (perceptions) that the SMEs have about Prestwick activities and change areas.

The analysis uses indirect testing of the stated changes at Prestwick to see if the perceptions of management are relative to the actual changes being undertaken. This particular analysis includes manufacturing lead times, change requests, professionalism, forecasting, and communication improvement efforts by Prestwick, all of which were chosen as being representative as indicators of mutual beneficiality and/or commensality, both of which are considered necessary components of changing relationships.

5.1.1 Manufacturing lead times

This series of questions was designed to determine attitudes at the major manufacturers production and purchasing levels concerning lead times for its component suppliers. This is an important factor, indicating symbiosis through mutual respect for proper lead-times by the entities involved.

Lead-time includes necessary design work, prototypes, tool and jig building, ordering of materials, set-up time for machinery or processes, and scheduling production, all within a normal operating cycle.

Under symbiotic conditions, this lead-time is a realistic period that allows for smoother production and delivery procedures, and yet provides a certain degree of flexibility for both parties involved. Proper lead-time is mutually beneficial because the larger organisation receives benefits of on-time delivery, and perhaps higher-quality products, if timing is reasonable for the producing entity. The supplying firm receives the benefit of being able to order materials economically, design the prototype, set up equipment and integrate the production build smoothly with other production schedules.

Prestwick's stated goal is to project, as far as realistically feasible, a build programme that allows its component suppliers sufficient time to complete their planning and deliver the designated parts on schedule. This build schedule starts at the desired (or contracted) completion date of the aircraft and works backwards, calling off various parts and components necessary to complete each particular portion of the aircraft by the designated 'time window'. (Often referred to as 'backflushing'.) The appropriate parts, materials and component suppliers are provided with copies of the build schedule and are sent updates and revisions regularly.

During interviews with Prestwick's middle-management personnel, they admitted, that in practice, the build window is frequently changed. According to Prestwick, changes occur because of new orders or cancellations, current economic conditions, production schedule changes (usually delays) or modification orders for the aircraft. Occasionally, rush change orders are mandated because of safety reasons, but both entities did not believe this to be a problem.

Table Two - SMEs' Impressions of Prestwick's Respect for Manufacturing Lead-Times

Respondent's Position at SME	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Manager	3	2	1	9	4	3	2
Marketing	0	0	0	3	0	1	1
Production	0	0	1	1	0	0	0
Others	0	0	0	3	0	0	0
Totals	3	2	2	16	4	4	3
Column %'s	9%	6%	6%	46%	12%	12%	9%

n = 34

Prestwick was considered by thirty-three percent of the respondents to respect lead-times for component and materials better than other companies dealt with. Conversely, twenty-one percent of the respondents indicated that Prestwick had less respect for lead-times. (Twelve percent positive differential.)

The twelve percent positive differential, when coupled with the forty-six percent of the respondents who consider Prestwick at least as good as other major manufacturers, assists any symbiotic relationship built upon good communications. Several respondents felt that this Prestwick policy encourages better communications between the two entities, in additional areas other than production, for the mutual benefit of both parties.

This result does indicate mutual beneficiality, or symbiosis, because of the attitude of communications benefitting production scheduling and planning for both entities involved.

The most common complaint about Prestwick by SME management was the inordinate amount of time consumed by middle-management concerning order placement and setting of delivery dates. The SMEs indicated that they usually were not given an adjustment to the contracted

delivery date for this lost time. They had little argument concerning the production personnel and production management at Prestwick. For delay problems they faulted general staff's middle-management and procurement personnel, who appeared to be inexperienced in predicting shortages or timing and scheduling problems.

As an incidental note, some of the other BAe sites are beginning to establish computer linkages to their suppliers for improving this type of communication, but Prestwick has not installed this capability as yet. Several of the component suppliers that were involved with the pilot programmes had mixed reactions about the electronic interface. Some expressed concern about industrial 'snooping' or unauthorized access, and were not in favour of this system.

5.1.2 Number of change requests by Prestwick

Another indicator of symbiosis is the smooth flow of work flowing between two entities, and 'adaptation to change' required by customer demand, design modification, or safety reasons once an order has been placed. (Referred to as 'work-order changes' or 'change-orders'.) Close working entities accommodating work change-orders appear to be more symbiotic than adversely oriented firms, which often resist or resent necessary, and often inevitable, changes.

The major manufacturer was queried on its procedures for submitting change requests and under what circumstances. In a similar manner, component suppliers were questioned about their procedures for acceptance of change requests for orders already received. Both of these procedures are deemed necessary to establish the closeness of the working relationship in the work environment of the dissimilar-sized firms.

Table Three - SMEs' Impressions of Prestwick's Work-Order Change Requests

Respondent's Position at SME	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Manager	2	1	2	10	4	3	2
Marketing	0	0	0	4	0	0	1
Production	0	0	1	1	0	0	0
Others	0	0	0	3	0	0	0
Totals	2	1	3	18	4	3	3
Column %'s	6%	3%	9%	53%	12%	9%	9%

n = 34

Thirty percent of the respondents felt that Prestwick, once the order was placed, made fewer change requests than other companies dealt with. Eighteen percent of the component suppliers believed that Prestwick made more changes than other aerospace companies. This twelve percent positive differential, when coupled with the fifty-three percent who rated Prestwick at least equal to other manufacturers, indicates a symbiotic relationship between the procurement, production, and engineering personnel of both entities. This relationship helps in realising the mutual beneficiality of smoothing production flow and thus affects commensal production and delivery schedules of both parties concerned.

Prestwick's policy objective is to accomplish low-priority changes in the next ten aircraft batch, whenever possible. If a change is necessary, because of customer request or for valid safety or other business reasons, Prestwick attempts to immediately communicate it to all affected parties. This policy was practiced by production and procurement management interviewed, and also mandated by the Prestwick written policy statement.

Change orders often involve engineering drawing changes, which means one department can become a constraint to the entire system. Not

unexpectedly, many component suppliers and production personnel with Prestwick expressed concern about the inordinate amount of time (their phrase) taken by engineering before the change order could be released, thus placing undue pressure upon production units to comply within the time constraints.

The few negative comments made by the SMEs concern Prestwick's engineering department's lack of timely response to queries, changed parts not fitting the component, and other complaints reflect complaints normally experienced in a manufacturing environment. The component suppliers, however, candidly acknowledged that many of the changes were required by governmental agencies or requested by customers, and did not originate from internal Prestwick sources. Therefore the 'blame' really did not belong upon Prestwick for the change orders, but were caused by exogenous factors.

A trust relationship between engineering and production and between prime and sub-contractors is useful for fostering mutual beneficiality, and mutual dependency by both participants. Each of these mutualities are a necessary precedent condition for symbiotic change to occur between the two different sized entities.

5.1.3 SMEs' impressions of Prestwick's professionalism

Arguably, the more professional a major manufacturer's staff and management team are perceived to be by its component suppliers, the more likely that a mutual feeling of trust and cooperation will develop. This feeling of trust is considered one of the cornerstones of symbiotic change and is considered one of several steps in development of long-term relationships by Prestwick.

Table Four - SMEs' Observations of Prestwick's Overall Professionalism

Respondent's Position in SME	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Manager	2	3	4	6	4	3	2
Marketing	0	0	0	1	1	2	1
Production	0	1	1	0	0	0	0
Others	0	0	0	1	1	1	0
Totals	2	4	5	8	6	6	3
Column %'s	6%	12%	15%	24%	18%	18%	9%

n = 34

Prestwick's overall management team is considered more professional than that of other aerospace companies dealt with by forty-five percent of the interviewees. Conversely, thirty-three percent consider Prestwick less professional. This twelve percent differential indicates a feeling of respect for the major manufacturer, which can be strengthened further by considering the 'same as equal' rating of twenty-four percent.

As stated earlier this professional attitude is a keystone for developing long-term trust relationships between the two entities, and is considered a positive factor for symbiosis. Although this trust factor has intrinsic value, it is difficult to measure in a quantitative manner. The advantage of using a semi-structured interview is that the nuances of respondents' answers can be observed and recorded, and used as additional background information in determining the existence of this trust. For example, one of the higher rated qualities establishing professionalism was the willingness to share bad news as compared to just communicating good news. (e.g., downturn in number of units to be produced, discontinuance of a model etc.) Several of the respondents indicated that they believed Prestwick was exceptional in its desire to communicate all types of changes and decisions, not just 'good news'.

Spontaneous comments made by the SME respondents include Prestwick's management teams are approachable, and that they are striving to make changes that will benefit both concerned parties. Most of the respondents believed that it would take time to see whether the changes are permanent or temporary. Several of the respondents stated that, if the changes are long-term, this will be beneficial for UK businesses in general, not just aerospace, because of the 'spillover' effect into other major manufacturers and other industries.

Three of the negative respondents argued that Prestwick is short-term oriented, and will switch from buying-in of components to manufacturing in-house without prior warning. These companies were also critical of the attempts to establish a partnership relationship, believing that this would be accomplished only if it were in Prestwick's best interest, to the possible detriment of the component suppliers.

It is noteworthy that over eighty percent of the respondents were very specific in their spontaneous comments that Prestwick is different (favourably) from other BAe sites that they had dealt with. The SMEs particularly praised Prestwick's production and quality assurance personnel.

5.1.4 SMEs' impressions of Prestwick's forecasting skills

The projected build-programme is one of the more useful tools that a major manufacturer can employ to install a feeling of partnership with component suppliers. This feeling is important to establishing beneficiality amongst the participants in symbiont changes. If the build-programme is reasonably adhered to, and is projected far enough in advance to allow timely purchasing decisions and production planning to take place, it can be an excellent builder of symbiosis between the two entities. At Prestwick, this programme contains information generated on-site and from the Central Sales Office located at Corporate Headquarters, Hatfield.

Table Five - SMEs' Impressions of Prestwick's Forecasting Skills

Respondent's Position in SME	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Manager	3	0	2	10	5	3	1
Marketing	0	0	2	1	1	0	1
Production	0	0	1	1	0	0	0
Others	0	0	0	2	1	0	0
Totals	3	0	5	14	7	3	2
Column %'s	9%	0.0%	15%	41%	21%	9%	6%

n = 34

Prestwick was considered by thirty-six percent of the respondents to have a better long-term perspective of its build needs then other BAe divisions or companies dealt with. Conversely, twenty-four percent believed that Prestwick was worse than that of other aerospace companies dealt with. (Twelve percent positive differential.)

This positive differential, when considered with the forty-one percent who believe Prestwick is at least equal to other manufacturers, indicates a symbiotic relationship because of the mutual beneficiality of the communications undertaken. Forecasting is a necessary element of strategic planning and operational planning, therefore the closer the relationship between the dissimilar-sized entities the more likely mutual beneficiality will result, and symbiotic change can occur.

Virtually all interviewed component suppliers stressed how important it was for their relationship with Prestwick to be included in the distribution of the build programme - to be 'part' of the family or partnership. The feeling of long-term relationships and mutuality of benefits is engendered by this form of communication.

There were some SMEs who voiced negative comments about the validity of the build window and production scheduling. An interesting

observation was that similar criticisms occurred internally at Prestwick. One criticism was that the planning-purposes build-window programme of twelve months, although a definite improvement over past scheduling methods, was not long enough. Secondly, criticisms were made about schedules frequently modified. Respondents cite German aerospace companies as a better example, which often submit a three to five year planning window and make changes to it only infrequently.

Internally, several mid-level production and procurement managers at Prestwick were critical of the flexibility in the build schedule, favouring build-uniformity, even if some of the aircraft became greentails (unsold aircraft). They believed that build uniformity will result in smoother production flows and facilitate procurement and delivery procedures. They strongly believed that this would ultimately save more in production costs than unsold inventory, if any, would cost.

These comments illustrate the classic struggle between strategic planning and balancing production line and procurement procedures. (In essence, management vs. production philosophies.) They may also indicate slower acceptance by production personnel of flexible manufacturing procedures than managerial policy envisages. It must also be considered that the environment these comments were made was during a period of total aircraft pre-sales, with backorders extending well beyond the build programme. The question left unanswered is whether these managers would have differing opinions during times of slow sales and/or unused production and facility capacity.

5.1.5 SMEs' impressions of Prestwick's communications efforts

Prestwick's management has made a great deal of effort to establish communications links internally with its workforce and externally with its

customers, suppliers and sub-contractors. The perceived communication efforts of Prestwick are critical to establishing long-term relationships, and thus symbiosis, with the component suppliers.

Table Six - SMEs' Impressions of Prestwick's Communications Efforts

Respondent's Position at SME	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Manager	2	1	2	9	4	2	4
Marketing	0	0	0	0	2	3	0
Production	0	0	0	2	0	0	0
Others	0	0	0	2	0	1	0
Totals	2	1	2	13	6	6	4
Column %'s	6%	3%	6%	38%	18%	18%	12%

n = 34

The SMEs were questioned not only to determine whether they saw changes in communications efforts or procedures by Prestwick, but also to establish what changes, if any, they had made in their own communication procedures. These questions were extended at the SME level to see if they were attempting to change their communications with their suppliers as well as with Prestwick. This mimicking of Prestwick's procedures by the SMEs towards their suppliers would be a strong indicator of symbiosis.

Prestwick was considered to have better overall communication skills by forty-eight percent of the respondents, compared to fifteen percent who believed them worse than those of other companies dealt with. (Thirty-three percent positive differential, which is the best of the various factors queried.)

This positive differential, when considered with the thirty-eight percent who perceive Prestwick at least equal to other major manufacturers, makes a strong indication of a symbiotic relationship developed by communication skills.

Many of the favourable spontaneous comments reflected the feeling that the suppliers were kept in the information flow and could depend on being told the status of a build programme, even in the event of a decrease or other 'bad-news' message. Others commented that they could freely call Prestwick personnel in various departments, not just the buyers. Production, quality assurance, and engineering received high marks for their openness to communicate.

5.2 SMEs' Perceptions about Prestwick's Changes

Once it was established that Prestwick and the SMEs considered the changes mutually beneficial and even commensal, the SMEs were questioned about the expected ultimate effect upon their company of the changes at Prestwick - either favourable or unfavourable with a Lykert scaling between the two polar answers.

The purpose of this series of questions was to determine a measurable response, using a Lykert type scale, of management's beliefs and perceptions about the changes underway at Prestwick. Although these responses are not precise quantifiable data, but rather represent the opinions and perceptions of the operational personnel involved within the civil aerospace sub-contracting industry, they are indicative of the ultimate effects of change 'downstream'.

It was determined that these managerial perceptions contribute to the study of symbiotic change because they triangulate the previous answers about awareness of change, level one, and they establish the base for measuring mutual beneficiality of the changes.

Table Seven - SMEs Response About Observed Prestwick Changes

Response to Prestwick Changes Observed by the SMEs	Unfav <<<<<<<< 0 >>>>>>>> Fav 1 2 3 4 5 6 7
1. JIT Production Methods	4.0 0
2. Total Quality Control	4.6 +
3. Single Sourcing	4.8 +
4. Cost/Risk Sharing	3.8 -
5. Smaller Lot Sizes	3.3 -
6. SME Design & Engineering	4.5 +
7. Supplier Product Liability	3.7 -
8. BAe Stock Reductions	3.8 -
9. Long Term Relations	4.8 +
10. Feeling of Partnership	4.5 +
11. Adverse Buying Attitude	3.9 -
12. Production Schedules	4.0 0
13. Vendor Pay't Procedures	2.7 -

Table seven above measures the SMEs opinions of Prestwick's changes using a seven point Likert type scale. A + indicates a favourable response and a - indicates an unfavourable reaction to the change. A neutral reaction is indicated by a zero.

(1) JIT production methods

Prestwick's change to just-in-time production methods (primarily assembly cellular manufacturing) was commented upon by ninety-four percent of the SMEs who had observed changes at Prestwick. The overall effect upon the SMEs was considered favourable by fifteen percent, while seventy-four percent feeling that the changes had a neutral effect. The

remaining eleven percent expressed disagreement with the changes and believed the overall impact unfavourable upon their firms.

The large neutral opinion is partially explained by the aerospace industry's emphasis on quality and delivery changes, which focuses less direct attention upon the production methodology changes. The production methodologies are cohesive and pervasive in the civil aerospace sector because of the special techniques and materials used, which also partially explains the neutral rating.

Further reasons for the large neutral rating include the fact that many of the component suppliers operate in several industries, particularly automotive and electronic; and the existence of long standing relationships established over many years of working together. Both the automotive and electronic industries encounter frequent change; therefore component suppliers were less likely to identify favourable production changes specifically influenced by the aerospace industry.

(2) Total quality control

Prestwick changes in total quality control culture or philosophy was noticeable to ninety-seven percent of the SMEs interviewed. Of these, thirty-two percent felt that the changes had a favourable effect upon their operation, and sixty-five percent were neutral. There were no respondents who felt unfavourable effects.

The observed change towards total quality control (TQC) methods by Prestwick was deemed to have a positive effect upon the SMEs. This may be partially explained by the fact that those firms that can meet the higher quality standards may receive defacto protection from lesser-qualified competitors and therefore perceive this as a welcome change. The commonality of high quality standards is also a factor for cohesiveness

amongst the participants within the civil aerospace industry - the SMEs have come to expect quality standards mandated by government and customers.

(3) Single sourcing

The change towards single-sourcing by Prestwick was rated highly by the respondents. This response must be viewed in perspective that the current supplier list contains the 'survivors' of this sourcing policy change of reducing the number of suppliers.

The SMEs recognised the benefits of single-sourcing, including longer-term contracts, better communications, production planning and scheduling and product quality control. Many of the management personnel admitted that although they agree with the concept of single sourcing, they are doubtful of its total implementation throughout British industry because of die-hard traditional buying practices which do not trust this concept.

(4) Cost and risk-sharing

Prestwick's change towards cost-participation and risk-sharing was not perceived as beneficial for the SMEs by the respondents. Several managers stated that they refused to participate in cost contributions, and were not willing to participate in launch-cost risk-sharing because of their financial position. These managers believed that the major manufacturer should bear research and development costs as part of its normal aircraft introduction planning. This viewpoint is an apparent contradiction to the commensal relationship or feeling of partnership sought by Prestwick.

(5) Smaller lot sizes and build-sets

Prestwick's reductions of lot size from thirty build-sets to ten were observed by ninety-one percent of the SME respondents. Only six percent of the respondents thought that this change was beneficial to their firms. Sixty-five percent of the respondents were neutral about the change effects, which demonstrates again the industry cohesiveness, and twenty percent

believed it was detrimental to their operations. Of this twenty percent, twelve percent rated it as highly unfavourable to their firm.

This unfavourable rating possibly indicates a lack of understanding of just-in-time manufacturing techniques and correlates to the number of firms that are not implementing JIT procedures at this time (eighteen percent).

Smaller lot-sizes were rated unfavourable by some SMEs because they prefer to manufacture in larger batches using traditional procedures. This apparent contradiction of the acceptance of JIT manufacturing methods may indicate a lack of awareness of just-in-time benefits, or may indicate the traditional conflict in goals between production and managerial personnel.

(6) Supplier design and engineering

SME design and engineering changes were received more favourably than smaller lot sizes. The SMEs believed, when asked to design a component or sub-assembly, that they had the inside track for the build-life of that component. This policy gives the SMEs desirable input into the specifications and manufacturing methodologies to be used, obviously corresponding to their engineering and build capabilities and specialties.

(7) Supplier product liability

The SMEs did not perceive Prestwick's change toward supplier's responsibility for product liability as beneficial to them. This is a formal change in policy whereby Prestwick expects the part supplier to replace any defective parts found in operation directly to the customer. Several of the firms stated that their liability did not extend beyond the acceptance by Prestwick of their component. However, in practice, many suppliers normally replaced defective parts without question regardless of the time elapsed from original shipment or installation. From the SMEs point of view the real issue is how long the warranty period will be under this new policy.

(8) BAe stock reductions

The stock-reduction programme of Prestwick was received unfavourably by the component suppliers. Several of the SMEs stated that the initial programme was implemented without prior warning. The managers felt they were affected financially during the period of no stockage orders. Others felt that they had become Prestwick's stockist for expensive components or materials; Prestwick had merely passed the inventories 'downstream' to their suppliers. Prestwick is attempting to overcome both of these concerns through better communications and providing blanket purchase orders with major suppliers that the SMEs may order from.

(9) Long-term relationships

The change toward long-term relationships between Prestwick and its suppliers was received favourably by the component suppliers. There appeared to be an initial period of doubting Prestwick's motives; if this initial doubt could be overcome, and a feeling of trust built, the partnership relationship is considered valuable by the respondents.

(10) Feeling of partnership

A similar feeling of partnership between the two entities concerning production scheduling, quality controls, and product modification or development was perceived as favourable by the SMEs. Prestwick is attempting to engender this feeling by better communications and including the suppliers in the design process, as well as building longer-term relationships in their purchasing/supplier interface.

(11) Buyer's attitudes

The SMEs had not perceived a complete change in the adversarial buying attitude amongst the buyers at Prestwick. They believed that they were given lip service concerning delivery, quality and pricing, but whenever Prestwick's buyers called all they wanted to discuss was price. A middle

manager in Prestwick's purchasing department admitted that they always 'hammer away at pricing' in spite of the stated policy change to total delivered cost. This comment added credence to the SMEs' perceptions mentioned above. This lack of attitude change indicates a breakdown of top management's objective of establishing better communications with their component suppliers.

(12) Production schedules

The sharing of production scheduling and projected build-windows was welcomed by the SMEs. Prestwick's change to a build-window of at least one year was perceived as a sincere move to better communications and planning amongst the partners. This benefit was offset to a limited degree by the frequency of changes to the schedule was subjected by the production planners and engineers at Prestwick.

(13) Administrative information

The major negative perception of the SMEs was the attempted change by both BAe and Prestwick in vendor payment procedures and payment timing. Attempts to lengthen the payment schedule caused financial disruption and cash flow timing problems for the SMEs. This attempted change was negatively received by the SMEs, however it did illustrate the improved communications efforts by Prestwick in their willingness to share good and bad information on a timely basis.

Other comments by the interviewees noted a positive reduction in paperwork as group-wide certification inspections became more fully implemented. Other administrative changes were an open order system, certification of suppliers, and more use of computerised ordering. Discussions are being held about computer net-working concepts between Prestwick and its suppliers, but this is in the initial planning stage.

6.0 CHAPTER CONCLUSION

This chapter explores the prime manufacturer, British Aerospace, Plc. in general and the civil airlines division, Prestwick, specifically.

The second section establishes that - British Aerospace Plc, Civil Airlines Division, Prestwick, is undergoing significant changes. The changes documented during this study include production, quality, purchasing, and management information systems and procedures.

Prestwick's management objectives are to implement changes in: corporate quality culture, personnel orientation and training, assembly cell manufacturing techniques, and inventory stock reductions. Management desires to implement these changes in-house at Prestwick, and hopefully to have them adapted by their component suppliers.

The final section then explores the consequences of these specified changes, 'downstream', to the component suppliers. The table from chapter one is used as a discussion focal point to establish the awareness of Prestwick changes by its SME's, and their perceptions of the beneficiality of the changes underway. These perceptions are included in this chapter because they directly reflect upon the ultimate affect of change - the changing relationship between the prime contractor and its component suppliers.

The next chapter examines these issues in some detail from the perspective of the component supplier, and continues the analysis from the table one perspective from chapter one.

CHAPTER SIX INDEX - **PRESTWICK'S SME COMPONENT SUPPLIERS**

CHAPTER SIX - **PRESTWICK'S SME COMPONENT SUPPLIERS**

1.0 INTRODUCTION

The primary question answered by this chapter concerns the current operating environment of thirty-four small and medium-sized component suppliers to Prestwick. This operating environment is described using a twofold approach:

(1) A description of the present state of the small and medium-sized component suppliers as found during this research, using the narrative approach of exploratory methodology.

(2) A description and analysis of the symbiont relationships existing between the major manufacturer and its component suppliers.

2.0 SMALL AND MEDIUM-SIZED COMPONENT SUPPLIERS TO BAe, PRESTWICK

2.1 Present State of the SME Component Suppliers

The SMEs interviewed in this research are geographically dispersed throughout Britain, operate in several industries simultaneously, and have less than 400 employees or £25 million in annual turnover. The managers (or owners) of these companies have observed changes underway at Prestwick and perceive varying degrees of influence from Prestwick upon similar changes within their firms. This section gives further information about the companies, the interviewee and their awareness of the world around them. Several operational factors and economic theories that are specific to this research are discussed and applied to this research.

This section narrating the SMEs' operating environment and potential effect upon symbiotic changing relationships contains four separate elements:

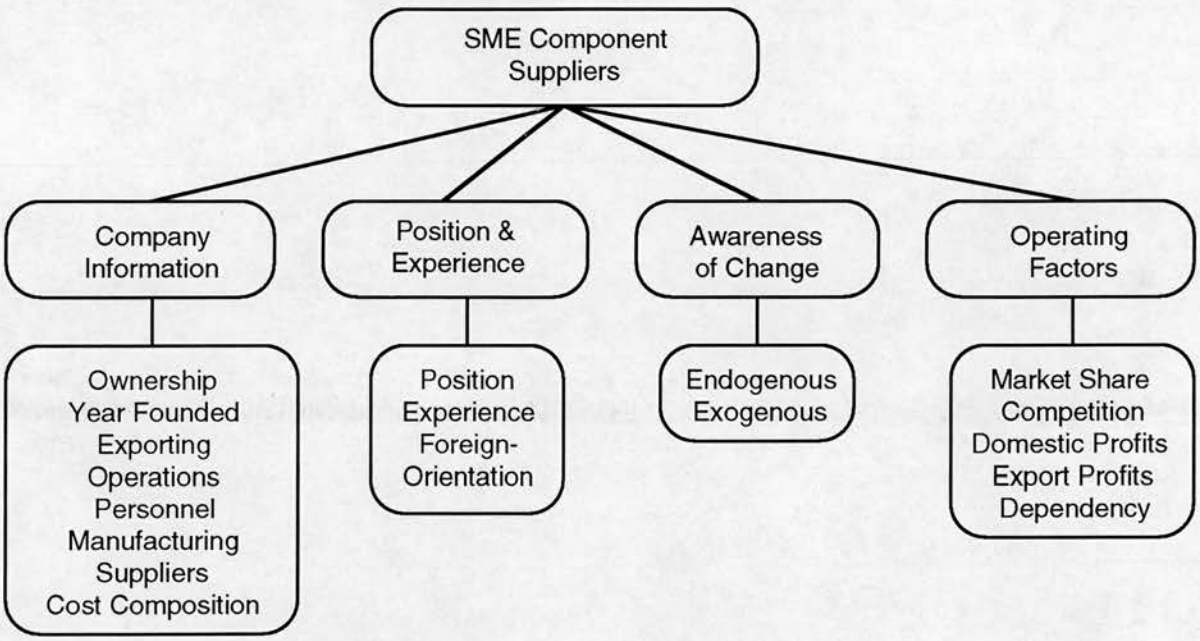
(1) company information,

(2) interviewee's position and experience,

(3) management's awareness of change, and

(4) operational factors and economic theories.

Figure One - SME Operating Environment



2.2 Company information

The managers, during the initial part of the interview, provided general background information concerning the company's type of ownership, business life, and exporting orientation. This information is necessary for understanding the companies' normal operating environment and experience. The companies' operating environment may be distinct from managements'; influences are exerted by other segments of the organisation, not just by the manager interviewed. For example, one manager interviewed admitted he had never been involved in exporting

while he was rising through management ranks, but his company currently exports. This disclosure illustrates that the company has an expertise that the manager doe not; he delegates the exporting aspect to his subordinates with minimal oversight from himself. This is the type of illustration that justifies a company profile discussion, adding richness to the research.

(1) Ownership

The type of entity establishes the difference between closely-held entities and widely-held Plcs'. This ownership difference is important to place into perspective the types and amounts of influence other personnel have upon the organisation in contrast to those of the respondent interviewed. Twenty-nine percent of the component suppliers were closely-held companies, primarily limited corporations. The others were either subsidiaries of larger corporations, or publicly-holding companies with widely-held ownership. Six (eighteen percent) of the respondents were the original founders of their companies. Seven companies, previously closely held, had been purchased by larger companies within the previous three years.

An interview with a manager who had sold his company one year ago to a larger foreign company disclosed positive results. This manager was now able to compete for larger contracts and had just recently won a contract with Rolls Royce for work that he would not have attempted previously. He believed the sale of his company had resulted in a larger capital base and access to other divisions that could support his bid for new types of work. A different type of experience was related in an interview with a new management team from a larger Plc that had purchased a firm previously owned and managed by women. The new management team (male) were having discouraging experiences relating to the workforce and

customers, who were comfortable dealing with the former female owners and executives.

(2) Year founded

Determination of the year of formation assists in establishing the experience and history of the company. Although admittedly this is an intangible measurement, it places into perspective the responses given. Management of long-established companies may have a different perspective about symbiotic change than younger firms. For example, a firm established in the 1800's was managed by very conservative persons who were aware of their tradition and status within the community. A different perspective is gained from an interview with the manager of a firm only a few years old. The newer firm gave the interviewer an impression of a more aggressive business style and more innovativeness, and less social involvement. Nine percent of the companies were formed before the beginning of this century. Half (median) of the companies were in business before 1955.

Seventy-nine percent of the companies were formed before the Conservatives gained control in the early 1970's, which may be indicative of that political party's policies toward smaller businesses. Many of the managers interviewed were critical of governments' approach to aerospace companies in general, feeling there was not a consistent policy that they could count on. One manager was extremely bitter about having his former company literally nationalised by the government during the 1960's without his consent. (Not verified by this research.)

(3) Globalisation (foreign orientation)

Half of the companies began exporting before 1964; twenty-one percent, however, have never exported. This lack of foreign orientation seems incongruous with the global orientation of the aerospace industry.

This may be partially explained by the fact that many component suppliers deliberately choose to operate within Britain, preferring to deal with British airframe assemblers or engine manufacturers.

Of the companies that did export, several spontaneous comments indicated that the initial foreign orientation was obtained indirectly through British Aerospace, Rolls Royce or Westland contacts. These contacts presented further opportunities to deal with American, Canadian or European aerospace firms. This 'piggybacking' of marketing channels eventually led to exporting directly to the foreign firms without using the British aerospace intermediary. This piggybacking exporting technique is being encouraged by British and American governmental agencies.

(4) Operating Summaries

Table one, below, summarises the annual turnover, planned annual growth rate and turnover mix or composition of the SMEs interviewed. This information is useful for understanding the effects of marketing, product mix of aerospace and non-aerospace, and growth within the aerospace industry.

Table One - Analysis of Annual Turnover

Annual Turnover by the SME's (Amounts shown in £ 000's)	(Median)	Mean	Minimum	Maxi-mum
Sales - 1990, or current fiscal year	(4,000)	7,396	250	60,000
Sales - 1989, or prior fiscal year	(3,500)	6,560	230	54,000
Sales - 1988, or second prior year	(2,900)	5,543	100	45,000
Planned Annual Growth Rate	(10.5%)	12.4 %	0.0 %	25 %
Turnover Sold to Major Mfgr.	(75%)	75 %	10 %	100 %
Turnover Within Aerospace Industry	(55%)	53 %	8 %	100 %
Aerospace Turnover Exported	(3%)	13 %	0 %	60 %
Seeking more/same/less Aerospace Work		88 % more		12 % same

n = 34

Two interesting facts from the above table include the amount of annual turnover that SMEs sell to major manufacturers, a mean of seventy-five percent, and the mean of the sales within the aerospace industry, fifty-three percent. This may indicate a higher dependency upon the major manufacturer than management wants to admit. This table also indicates the amount of interaction within the aerospace industry, which strengthens the mutuality argument towards symbiotic changing relationships.

The change in sales gives an approximate trend measurement of growth during the past three years for the SMEs. The average planned growth rate is 12.4 percent per annum, whilst the actual results are eighteen percent from 1988 to 1989, and thirteen percent from 1989 to 1990. These growth rates correspond with the boom in the civil aerospace markets during the same time periods.

The number of firms exporting, a mean of thirteen percent, was consistent with the comments made by the interviewees about their tendency to not export and preference to deal with British firms only.

The unusually high percentage of firms seeking more aerospace work, eighty-eight percent, reflects the mutual beneficiality between the SMEs and the major assemblers and supports the symbiotic change query. The majority of interviewees stated that the primary reasons they are seeking more aerospace work is that it was more profitable and considered a growth industry, and that it keeps their skill levels at the leading edge which can be applicable to other work.

(5) Analysis of personnel

The purpose of this information is to bring into perspective the skill levels of the personnel amongst the small and medium sized companies interviewed. This information assists in understanding the exogenous influences upon the entity through managers, as well as internal influences.

The high number of production and manufacturing personnel interviewed is pertinent because many of the changes taking place are either in manufacturing or support the manufacturing changes. (e.g. JIT delivery changes support changes in JIT manufacturing techniques.) Quality assurance personnel are often in a position to observe changes taking place throughout a factory, so their observations are valuable also.

Table Two - Analysis of Number of Employees

Number of personnel in each position	(Median)	Mean	Smallest	Largest
Owners or General Managers	(6)	8	1	30
Marketing and sales	(3)	6	0	44
Engineering and R&D	(4)	7	0	40
Production	(63)	84	7	280
Administrative	(6)	12	1	52
Quality Assurance	(5)	6	0	30
Others - stores, drivers, etc.	(0)	3	0	42
Total Current Year	(99)	126	10	400
Total Prior Year	(88)	123	7	375

n = 34

As of the interview dates, the companies, on average, employed 126 personnel, including management. This compares with 123 employed in the previous year; a slight growth is indicated.

The stability of employment assists in verifying the spontaneous comments that better utilisation of personnel and increased use of computerised equipment accommodates the increase in sales, in lieu of increasing staff amongst the SMEs.

The interviewees suggested that they were able to handle the growth in sales by utilising personnel more effectively through multi-tasking, cross-training and computer numerically controlled (CNC) machines. Several of the CNC machines observed during the interviews were capable of

simultaneously running three separate work pieces, with tool turrets of over 100 tool capacity. In addition, one operator can normally run two or more CNC machines simultaneously. This greater machine flexibility partially accounts for the ability to handle increased volume without increasing the labour force.

Several SME managers commented that they were impressed by their labour force's favourable attitude towards multi-tasking and cross-training. They found this a welcome relief from prior strong union rules preventing this type of flexibility amongst the work force.

There appears to be a fairly uniform distribution of personnel involved in engineering, quality assurance and sales. The first two personnel categories emphasize the importance of delivering a defect-free component, the latter identifies the importance of competitive bidding and obtaining new orders on the books.

(6) Manufacturing methodology

The following information about the capacity of manufacturing equipment, average stocks, manufacturing lead times and delivery performance gives a perspective of the SMEs' current capabilities. This understanding assists in putting into perspective the SME changes discussed later in this chapter.

Table Three - Manufacturing Analyses

SME capacities and key operating measures:		Mean	Smallest	Largest
Equipment, Fair Market Value	(£ 000's)	3,425	60	20,000
Average Closing Stocks	(£ 000's)	768	1	3,600
Average manufacturing lead time	(weeks)	10	1	57
Lead time, one year ago	(weeks)	12	1	72
Late deliveries, regardless of the reason		13 %	1 %	50 %

n = 34

The capital intensity of the industry is indicated by the mean of £3,425,000 fair market value of production equipment, which often is tied up in a relative small number of CNC machines. Closing stocks are also a significant amount, almost eleven percent of annual turnover. Several comments were made that the component suppliers were bearing the brunt of the downsizing of inventories by the major manufacturers.

Manufacturing lead times are decreasing as more use of JIT manufacturing techniques and CNC equipment is being implemented. Even companies with the longest lead times, the forging and casting industries, were experiencing a decrease in their normal product lead time.

On-time deliveries and meeting promised dates was mentioned as a persistent British problem, but one which positive strides were being made. Several of the managers candidly admitted that the presence of Japanese manufacturing facilities within the British Automotive industry was positively affecting delivery performance in other industries. Apparently a positive experiential observation from these foreign owned facilities was that mandated on-time delivery schedules not only could be kept but were a necessary factor of JIT manufacturing.

One firm in the casting industry did admit to being fifty percent late in their deliveries, a fact that they were not proud of but were apparently not making significant improvements upon. This firm was concerned about foreign intrusion into their field because of their late delivery record, with the possibility of a foreign owned facility locating in Britain to directly compete with them in the near future.

(7) Supply sources

The source of materials and components used by SMEs is important to identify because this gives a perspective of their internationalisation and global activities.

Table Four - Supply Sources

		Mean	Minimum	Maximum
UK Suppliers	(May be imported)	83 %	30 %	100 %
EEC Suppliers	(May be imported)	8 %	0 %	50 %
U.S.A. Suppliers	(May be imported)	8 %	0 %	60 %

n = 34

The majority, an average of eighty-three percent, of the SMEs purchase from British firms, even though they may be buying imported goods or materials. Spontaneous comments made during the interviews suggest that this was more convenient, conforming to the SMEs' traditional method of doing business.

Several of the managers commented that purchasing locally is normally faster than purchasing abroad. Another partial explanation of this phenomenon to purchase locally is that certain aerospace materials are scarce world-wide, and an allocation system is used that mandates loyalty to one supplier. This loyalty translates into continually purchasing from a local firm that has a history of supporting the SME, and not price shopping.

Because of Prestwick's occasional 'out of stock' call-up, or for surge-capacity requirements, several firms stated that they had to stock expensive specialty materials. This stockage of excess specialty materials defeats the purposes of JIT production and procurement policies, and increases manufacturing costs.

The smaller firms, buying limited quantities of rare or premium-priced aerospace metal, felt manipulated by the larger-sized metal producers. The SMEs perceived the large producers as often dictating terms, quantities, prices and delivery dates by establishing quotas, and appearing to have a 'take it or leave it' attitude. As mentioned previously, Prestwick is trying to alleviate this disadvantage by placing blanket purchase orders for these

types of materials, giving authority to its SMEs to draw (purchase) from the blanket order.

A frequently-heard SME management comment was that foreign (e.g., EEC and U.S.A.) aerospace markets are difficult to break into, often taking years to obtain the first order. Paradoxically, eighty-three percent of these SMEs do not place their purchases outside Britain; possibly failing to capitalise on networking benefits resulting from these relationships. Frank Shrontz, Boeing CEO, stated that Boeing has established a network of subcontractors in other countries, in part because those countries are then more willing to buy Boeing's planes.[58] (Reinforces the partnership concept).

(8) Changes in SME procurement

The establishment of procurement change is the next logical step in identifying symbiosis in changes between the two dissimilar sized organisations. One of the tests of symbiotic change is if one entity identifies change in the other partner and then implements 'mirror-image' changes in their operations. For example, have the SMEs implemented purchasing procedural changes similar to Prestwick's in their companies?

The interviews do establish that procurement change is taking place at the SME level. For example, whenever possible the SMEs are trying to have their suppliers improve delivery performance, deliver in smaller lots, and improve their quality. As discussed previously, however, many of the SMEs experience little 'clout' in negotiating with their suppliers, many of whom are large multi-national corporations. In spite of this size difference, many of the SMEs were convinced that they had improved communications with their suppliers and asked for improvements were beginning to be enacted upon by the larger suppliers.

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58. Tacoma News Tribune, July 25, 1991, p. D-1.

The largest area of improvement amongst the suppliers to the SMEs was increased on-time deliveries. The SMEs attributed this favourable increase to better communications between them, taking credit for initiating this change. The build schedule prepared by Prestwick was also considered an important factor in improving communications to the SME suppliers, as they could 'pass-on' estimated materials and parts needed by specified delivery dates earlier to their suppliers.

Table Five - Supplier Changes by the SMEs

	Increasing	Same	Decreasing
Number of Suppliers Utilised	21 %	50 %	29 %
Quality Standards	41 %	59 %	0 %
On-time deliveries	47 %	38 %	14 %
Communication skills	35 %	56 %	9 %

n = 34

Procedural changes are being made in the SME procurement systems. Their supplier base is decreasing in total, with twenty-one percent increasing the number of suppliers and twenty-nine percent decreasing. This observation agrees with the earlier discussion about changes in purchasing methods, whereby only twelve percent had made definite changes within the previous three years. Single sourcing, however, is still viewed with apprehension by most of the component suppliers, primarily because of their size and a history of slow delivery or not meeting promised schedules by their suppliers.

The quality standards of the suppliers were increasing, partly because of insistence by the component suppliers. Forty-one percent of the SMEs reported increasing standards among their suppliers.

An even better success rate is being achieved with the suppliers meeting their promised delivery dates. Forty-seven percent of the component suppliers reported favourable increases in number of deliveries

made on schedule. They believed this was a direct result of their efforts to improve communications as well as their on-site visits to their suppliers. The previously mentioned influence of Japanese auto makers present in Britain must also be considered.

According to thirty-five percent of the respondents, communication skills between component suppliers and their suppliers are improving. Only nine percent of the suppliers regard their communication efforts deteriorating between themselves and their suppliers.

(9) The SMEs product - composition of cost

It is important to understand product-cost elements because the components have a major influence upon the appropriate manufacturing, purchasing and administrative systems of both the SMEs and the major manufacturer. For purposes of this research, the principal product costs are labour, materials and overheads applied directly to the product.

Various elements of composition of cost exert different pressures on symbiotic change. For example, labour content may be favourably influenced by a flexible, highly skilled labour force, or hindered by a rigid, no-demarcation union ruled labour force. The reaction by labour to conversion to CNC machinery or cellular manufacturing techniques affects the SMEs' responses to similar changes at Prestwick.

In a similar manner, as direct materials gain imminence in product costing, the single sourcing policies of the major manufacturers will exert greater influence on the purchasing policies of the SMEs. Symbiotic change is more likely to occur in the areas of greater expenditure, which naturally draws more of managements' attention. Several of the SMEs stated that they are now being forced by Prestwick's JIT purchasing policies to stock high-cost exotic metals or other materials. These materials must be stocked

to meet the surge-capacity or aircraft-on-ground[59] response requirements to be a supplier to Prestwick under the new criteria. As previously mentioned, key component suppliers are designated to be surge capacity suppliers. This criteria means that the component supplier must have at least a ten percent increase in immediate manufacturing capacity for demand fluctuations not previously scheduled.

Table Six - Product Cost Composition

	Mean	Smallest Answer	Largest Answer
Direct Labour	29 %	10 %	60 %
Direct Materials	31 %	5 %	67 %
Applied Overheads	40 %	16 %	70 %

n = 34

According to the interviewees, direct labour is decreasing as a portion of total product cost. Equipment computerisation, multi-tasking, cross-training and other labour saving techniques introduced into the manufacturing system are major reasons for decreasing direct labour costs. The current direct-labour average for the interviewed firms is twenty-nine percent of direct costs.

In the modern manufacturing environment, as direct labour becomes less dominant, it is replaced by materials, components or application of indirect overheads; an example is computer support personnel for the CNC equipment.

The cost of material is rising as a percentage of direct product costs. Material is currently thirty-one percent of product cost for the component suppliers. The most common method of costing issued materials is the

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59. Prestwick has a marketing policy that if they receive a call from a airline customer that has a non-flyable aircraft on the ground because of needing a part, they will respond within twenty-four hours or less. This requirement is passed on to the SME component suppliers who are expected to meet this requirement.

specific identification method, used by seventy-five percent of the respondents, with a moving weighted average method used by fifteen percent of the respondents.

Applied overheads are forty percent of direct costs and are also rising as more administrative burdens are placed on the manufacturing process. One factor of increasing use of CNC equipment is the increase of technical support staff in administration to program and coordinate this type of equipment.

Effect of Learning Curve

An endogenous effect upon product pricing and costing is the learning curve theory. Ursic and Czinkota (1984) quote the Boston Consulting Group's (BCG) study which observes that costs on value-adding, in the production process, appear to decrease up to thirty percent when cumulative output doubles. BCG explain their findings by contending that greater product experiential knowledge leads to greater managerial, production, and logistical expertise, which in turn leads to lower costs.

The experience curve theory is specifically used in the aerospace industry in negotiating aircraft purchase prices. A twenty percent factor has been used consistently for each doubling of production beyond a certain minimum, which is compatible to the factor used by the Boston Consulting Group. (Newhouse, 1983; see also Porter, 1986).

2.3 Interviewees' position and experience

This series of questions to the respondents included their current job classification, professional experience, and foreign orientation to establish an informational base line of experience and overall business expertise. Although this base line may not be essential to this dissertation, it is useful in

understanding several of the responses to the questionnaire, and the changing symbiotic relationships.

(1) Interviewees' position

The positions of the respondents are important to establish the ability and credibility of the SMEs awareness of changes at Prestwick and within their firms. The more responsible position the respondents hold, the more likely that they are to observe and understand change. The job classifications of interviewees were: general managers - seventy-one percent; marketing managers - fifteen percent; and production or engineering managers - eleven percent. Amongst the general managers interviewed, a majority of more than sixty percent had progressed through the engineering or production disciplines into general management.

(2) Interviewees' experience

The average managers' experience within the primary operating industry of their present company was nineteen years. This industry experience is a sub-set of an average length of twenty-six years total business experience per respondent.

(3) Foreign orientation

Foreign orientation is important because the aerospace industry is global in nature and much of their sourcing is worldwide. In addition, the customers of the civil aircraft industry, the commercial airlines, are truly international and are increasingly from the Far-East.

One example of the need for foreign orientation is that several of the major manufacturers, including Prestwick, are attempting to shift product warranty from the supplier directly to the customer. For example, if an instrument fails, the customer does not contact Prestwick, but deals directly with the instrument manufacturer for repair or adjustment. This shift in responsibility not only affects global responsibility of the SMEs, but also

influences symbiosis because they are developing a commensal partnership orientation with Prestwick concerning warranty work.

The average interviewee's personal export experience was sixteen years; three respondents did not have any export experience. Although the interviewees frequently traveled abroad on business, averaging three trips annually, only twenty percent spoke a foreign language. Of the respondents who did not speak a foreign language, they frequently expressed dismay that their European counterparts spoke three or four languages. Fifteen percent of the respondents had lived abroad for business reasons. Of the total, forty-seven percent did not subscribe to foreign journals; and, twenty-nine percent did not travel abroad for business reasons.

2.4 Operating Factors Effecting SME Operations

The operating factors significantly affecting SMEs' management include market share, competition, domestic and export profitability, and market dependency. These factors were derived from answers from both the semi-structured questions and the spontaneous comments offered by SME management. These perceptions of operating factors relate to level two of the research objectives flowchart.

Figure (summary table) two below summarises managements' perceptions about the various operating factors affecting their companies. Their responses are derived from a 7-point Likert scale with parameters from very large increase to very large decrease. Their responses are not intended to be precise mathematical measurements, but rather perceptions about the various factors affecting their companies and their management decisions.

Figure Two - SMEs' Perspectives of Factors Affecting their Company

	DECREASE			Neutral	INCREASE		
# respondents & % of response	Very Large	Large	De-crease	Equal	Increase	Large	Very Large
1. Market Share/ Proportions	0 0 %	0 0 %	1 3 %	6 18 %	11 32 %	13 38 %	3 9 %
2. Competition/ Proportions	0 0 %	2 6 %	1 3 %	18 53 %	9 27 %	4 12 %	0 0 %
3. UK Profitability /Proportions	0 0 %	1 3 %	3 9 %	12 35 %	8 24 %	6 18 %	4 12 %
4. Export Profits /Proportions	0 0 %	1 3 %	4 12 %	13 38 %	3 9 %	4 12 %	1 3 %
5. Dependency on Major Co's/%	2 6 %	5 15 %	7 20 %	15 44 %	0 0 %	2 6 %	3 9 %

n = 34

(1) Market share

Managements' perspective of their aerospace market share indicates an awareness of change in Prestwick procurement and possible proactive or reactive changes in marketing methods by the SMEs. Seventy-nine percent of the respondents stated that their market share had increased each year for the past three years. Thirty-eight percent of these companies were experiencing what they considered a large increase annually. One explanation for this market share increase is the emphasis upon BSA 5750 certification, obtaining of which takes several years for newcomers to the market, thus providing existing suppliers a competitive market niche.

Amongst the firms not experiencing growth, eighteen percent of the respondents were maintaining their present market share, whilst three percent were losing market share. The latter two percentages are in industries where competition is very stiff because of standardised products. Some product specifications are common to the aerospace, automotive or electronic industries, creating a highly competitive, high volume, low margin

product range. Fasteners and connectors are two examples of this type of industry, in which standard, off-the-shelf products can compete effectively with the established aerospace companies' product, and thus erode market share. Another type of example would be a mature industry, e.g. metal forgings, which experiences no-growth or insignificant annual growth, as adjusted for inflation.

(2) Changes in competition

A proactive dynamic company may anticipate changes in competition by making internal marketing, production and quality changes. Awareness of competitive changes may indicate a symbiont company's managerial skills and be an indicator of reacting to change.

Thirty-eight percent of the respondents felt an increase in competition, in contrast to nine percent experiencing a decrease. This observation at first appears to be a dichotomy to their market-share experience. Their perception, however, may be explained by recent foreign entrants into the market, increased global sourcing policies by the majors, and recent certification of new suppliers domestically.

Several managers spontaneously commented that the Pacific Rim countries, especially Japan, China and Korea, were aggressively entering the aerospace market. These three countries are having a noticeable impact upon established UK firms. In addition, several countries[60] negotiate a portion of local content for parts and materials as a condition precedent to the purchase of aircraft, thus forcing the major assemblers to buy foreign instead of British components. This customer-imposed requirement for their countries' parts or materials content into the aircraft increases pressure on UK manufacturers to compete on a global basis. It also increases

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60. Most notably Japan and China.

resentment when the component supplier loses a contract or bid simply because the major manufacturer must comply with the buying country's requirements for local content parts or components.

(3) Domestic profitability

Profitability is often an incentive to enter into new markets or to increase present market-share. An awareness of, or reaction to, profitability can be an indicator of willingness to change, either strategically or operationally. In either case, symbiosis is facilitated by a participant's willingness to change in the purchasing-marketing relationship.

Fifty-four percent of the respondents were experiencing an increase in profits. The managers were increasing profitability by shifting production to more aerospace work from automotive or electronic industries, which traditionally have lower profit margins.[61] (Not documented in this research.) The type of build in aerospace is different from other industries, with higher precision and defect free requirements. The respondents believed that this precision could increase profit opportunities if accurately bid and if the build is managed properly. When queried, the managers believed this increased profitability is still feasible despite the increase in competition in civil aerospace.

(4) Export profitability

Twenty-four percent of the respondents were experiencing increases in their export profits. Managements' perceptions were that the increase was due to the heavy backlog of orders by American manufacturers; this backlog creates new global market opportunities for British firms. The fifteen percent who are experiencing a decrease perceived this as reflecting a

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61. Several of the managers spontaneously commented that whenever possible, they sought aerospace contracts, then electronics, and finally automotive. Their reasons for this conscious decision were growth, stability and profitability differences amongst the three industries.

tighter market from far Eastern competitors, as well as from traditional European and American competitors.

Twenty-one percent of the companies were not exporting; indicating that potentially lucrative markets were not being considered. When queried, these firms stated that they did not seek export work and would hesitate about considering serious inquiries from abroad. Their doubts about exporting were due to a variety of factors, including lack of experienced personnel, familiarity with documentation and tariffs, and mistrust in payment procedures. (These factors correspond to reasons for non-exporting discussed in the literature search, termed barriers to exporting.)

(5) Dependency upon major companies

The dependency upon a major manufacturer is a consideration for symbiosis because dependent companies are arguably more responsive to 'mandated' changes than are non-dependent companies. The awareness of dependency and a desire to change the status-quo may be other factors in defacto admission of symbiotic relationships by the dependent partner. A number of the companies were making efforts to become less dependent upon a few large manufacturers, attempting to spread their customer base.

This effort to become less dependent appears contradictory to symbiotic change, but in fact it supports symbiosis. The support to symbiotic change is present because the essential criteria defining symbiosis is acknowledged: dependency, mutuality and mirror-image changes. The definition used in this dissertation does not exclude the possibility that facts and circumstances may change in the future, either deliberately or through chance. The desired result is to identify symbiotic changes at the present time, not to anticipate a decrease or increase of future symbiosis.

Of the total firms interviewed, forty-one percent were wanting to decrease their dependency to some extent; fifteen percent were becoming

more dependent. The remainder, forty-four percent, were satisfied with the status quo for various reasons and did not plan to make significant changes within the next three years. The fifty-nine percent that were satisfied with the present relationship or desiring to increase their dependencies clearly are candidates for identifying symbiotic changes. The forty-one percent of the firms desiring to decrease their dependency are not eliminated as symbiotic candidates, in fact they may have a higher degree of symbiosis at the time of interview than the other firms.

Many companies have explicit policies of limiting their percentage of turnover to one company. This self-imposed policy is often initiated out of distrust in developing a close relationship with one major manufacturer for fear of becoming excessively dependent. Several SME managers, however, admitted that in specific short-term situations this restriction might be disregarded for valid business reasons. For example, one respondent's short term policy was to increase its market dependency to develop the expertise and production skills from a specific contract, with a long term goal of capitalising upon this expertise with other companies. Other reasons for increasing dependency were to justify purchase of specialized machinery and equipment, entrance into the aerospace market, and to increase operational profitability. Several managers commented that they were taking a calculated risk by increasing their dependency, but felt the results justified the risk.

At the present time, BAe Plc., does not have a specific policy limiting the percentage of a supplier's gross annual turnover that can be sold to one of its divisions. Several managers at Prestwick stated that they kept informal records and tried to avoid utilising more than twenty percent of a firm's capacity in the long-term; short-term considerations, however, might override this policy.

2.5 SME Awareness of Change in the Civil Aerospace Industry

To assess managers' awareness of change within the civil aerospace industry, it was deemed necessary to query respondents about their current observations and perceptions concerning two general areas of change within the civil aerospace industry - aerospace changes and exogenous operations:

2.5.1 Major changes within aerospace industry

In searching for awareness of change, managers were asked to rate the two most important changes within the aerospace industry during the past three years that had an effect upon their company. The most common management choices were:

(1) First choice

i. rapid growth within the aerospace industry,

ii. insistence upon defect-free delivery, and

iii. technological change, fiscal policies and other financial changes; all three of which were rated by the managers as equally important in their effect.

(2) Second choice

i. single sourcing policies of the majors,

ii. technology changes, and

iii. more out-sourcing by the majors.

2.5.2 Exogenous factors affecting SMEs

The queries concerning awareness of outside factors included managements' perceptions about any exogenous significant influences upon their business, ranked as first and second influential factors.

(1) Management rated the rapid change (technology push) faced by the aerospace industry as the single most influential external factor

affecting decision-making. Competition, the economy, and the influence of major manufacturers each received an eighteen percent ranking, tying for second through fourth ratings. The observations about the awareness of change, and the potential for reaction to it, and awareness of influence from major manufacturers are crucial criteria for establishing existence of symbiosis.

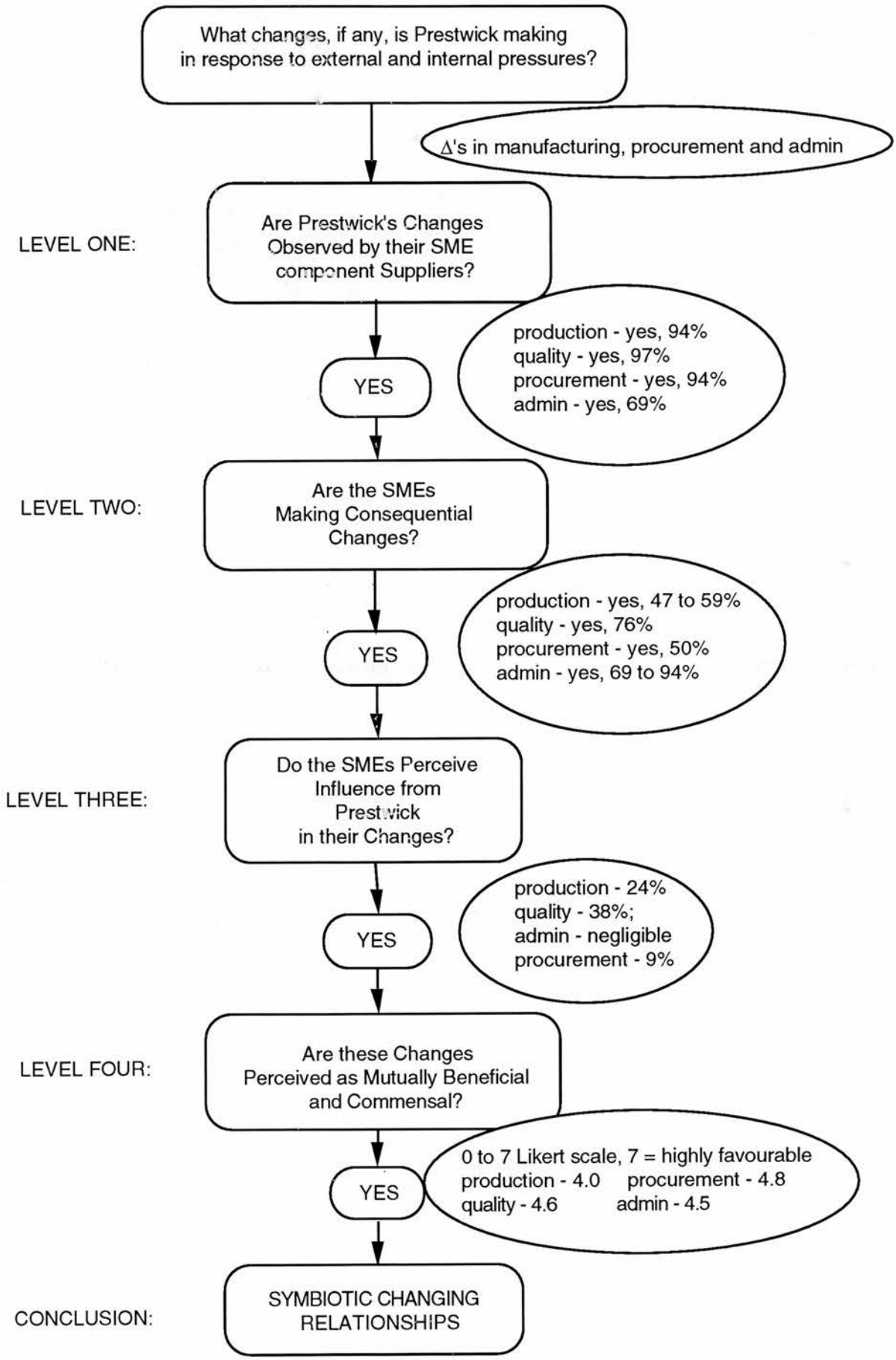
(2) The respondents' second choice of significant external influences included the general economy, interest rates and government policies affecting the SMEs operations. It is interesting to note that all three most popular second choices are connected with government influences upon the industry.

3.0 RESEARCH FINDINGS - SYMBIOTIC CHANGES BY THE SMEs

The purpose of this section is to describe and analyze the symbiont relationships from the SME component supplier viewpoints. To discuss their perspective, four aspects of change must be examined: SME awareness of Prestwick's changes, subsequent mirror-image or similar changes by the SMEs, perception of Prestwick influence upon SME changes, and the establishment of mutual beneficiality between the two entities.

Figure one from Chapter One is modified to show the results of the research findings of these changes in summary form, redesignated as figure two on the following page. Because the results at each of these levels indicate symbiotic changes, chapter seven discusses the conclusion that the relationships between Prestwick and their suppliers interviewed are changing in a symbiont manner.

Figure Three - Results of Symbiotic Changing Relationships



3.1 Level One - SME awareness of Prestwick changes

The SMEs were queried as to their awareness and observation of changes at Prestwick within the previous three years. The attempt was not to make a precise mathematical measurement of observed change, but to establish an awareness and, ultimately, possible consequences of the effect of changes by Prestwick upon changes at the SME level.

Table Seven - Prestwick Changes Observed by Their SMEs

Prestwick's Change Observed by SMEs:	%
JIT manufacturing methodology changes	94%
Total quality assurance changes	97%
Procurement changes	94%
Combination of above three changes observed by SMEs	80%
Administrative changes	69%

As shown in table seven above, eighty percent of the SMEs observed simultaneously all three of the change areas at Prestwick in manufacturing, quality assurance, and purchasing methods. Spontaneous comments were made to the effect that, although the aerospace industry is changing rapidly from an emphasis from military to civilian aircraft manufacturing, the changes at Prestwick were clearly observable and specific.

The more observed change, total quality assurance, is somewhat surprising in an industry known for its strict quality assurance. However, as discussed earlier, Prestwick is making changes in assigning responsibility for quality. This shift in responsibility is evident to their component suppliers, as evidenced by the ninety-seven percent of the component suppliers who were aware of the changes. This high proportion of observability also illustrates the increased emphasis on improving communications goal of Prestwick's management, as the new procedures evidently have been communicated to the suppliers.

Summary for level one - the SMEs have observed the designated changes underway at Prestwick as reiterated in table one. The respondents were clearly aware of manufacturing changes, quality assurance, procurement and administrative systems changes ranging from ninety-seven percent to sixty-nine percent. It is necessary to establish the existence of these observations before moving rationally to the next level of inquiry that will establish if consequential changes (either mirror image or similar) are being implemented by the SMEs.

3.2 Level Two - Changes by the SMEs

The second level of establishing symbiont changing relationships existing between the SMEs and Prestwick concerns mirror-image or similar changes by the SMEs within the previous three years.

This mutually changing relationship is explored using four approaches: (3.2.1) identifying mirror-image or similar changes by the SME component suppliers, illustrated in table eight;

(3.2.2) discussion of administrative system changes not included in table eight;

(3.2.3) correlation of SME and Prestwick changes;

and (3.2.4) the SMEs ranking of these changes.

3.2.1 Identifying mirror-image or similar changes by the SME component suppliers

This research established the existence of mirror-image changes being undertaken by the SMEs within the past three years. These changes are illustrated in table eight below, which indicates the stage of implementation of the changes as of the interview date.. The degree of influence by Prestwick upon these changes is discussed in other sections of this chapter.

Table Eight - Manufacturing Changes by the SMEs

SME CHANGES	Stage of implementation		
Type of change	Not Started	Partly In-stalled	Oper-ational
1. JIT Production Methods	52 %	30 %	18 %
2. JIT Delivery Procedures	41 %	21 %	38 %
3. Total Quality Control Culture	24 %	44 %	32 %
4. Statistical Quality Control Techniques	53 %	26 %	21 %
5. Faster Machine Set-up Times	64%	18 %	18 %
6. CNC Equipment, CAD/CAM Methods	38 %	24 %	38 %
7. JIT Purchasing Methods	50 %	38 %	12 %

n = 34

Discussion of Table Eight:

(1) Changes toward just-in-time manufacturing techniques were being implemented amongst a large minority (forty-eight percent) of the component suppliers that were interviewed. Although eighteen percent of the respondents had implemented manufacturing techniques as completely as current production justified, an additional thirty percent of the firms were planning further revisions to their manufacturing techniques. Fifty-two percent of the respondents admitted not starting new JIT techniques, either because of a lack of understanding of just-in-time, non-availability of funds, distrust in 'new' manufacturing systems, or perceived as not applicable to their business.

(2) Just-in-time delivery, defined as smaller lots delivered more frequently, seems to have had higher acceptance amongst the component suppliers interviewed than JIT manufacturing changes. Thirty-eight percent of the respondents believed that they had implemented JIT delivery fully. Twenty-one percent stated that they needed additional change to their delivery procedures to comply with the current requirements of the major

manufacturers. A minority of the SMEs, forty-one percent, was using older style, usually batch, delivery methods, and planned no change.

(3) Quality changes were the most implemented of the areas questioned. Thirty-two percent stated they had implemented quality controls fully, including shop floor responsibility for defects. An additional forty-four percent of the SMEs were making progress towards significant implementation of quality controls and attitudes. Twenty-four percent of the respondents had not changed their quality procedures for several reasons, as explained in the next paragraph.

Reasons for not making quality changes included beliefs that changes were not necessary because their quality procedures exceeded the BSA 5750 standard. (The Prestwick quality assurance personnel stated that the quality of the product was not the issue in many cases, but the requirement for traceability and documentation were problems for many of these firms. Simply put, the SMEs were not complying with the necessary paperwork.) Verification of both of these viewpoints is beyond the scope of this research and not attempted.

(4) Another measurement of a firm's change towards JIT manufacturing was statistical quality control implementation. Statistical quality monitoring was being used by twenty-one percent of the firms. Several firms included charts prepared by the operators and displayed them on the manufacturing line. Twenty-six percent were using partial variations of statistical control techniques, and fifty-three percent of the respondents had not implemented these control techniques.

(5) Conversion of existing equipment to faster set-up or change-over time had been accomplished by eighteen percent of the respondents. An additional eighteen percent were in the process of conversion, or replacement, with faster or multi-purpose equipment. Sixty-four percent of

the firms had not started this necessary step towards just-in-time manufacturing, primarily because of capital funding restraints. This finding agrees with the older manufacturing concept of large batch runs once the equipment is set-up, conflicting with smaller runs using JIT techniques.

(6) Computer controlled machinery was responded to more favourably by the component suppliers, with thirty-eight percent fully converted. An additional twenty-four percent were in the process of conversion, with capital funding and machine load-times the major considerations in determining conversion rates. Two companies were using computer integrated manufacturing (CIM) techniques, although, as of the interview date, not fully implemented. (E.g., missing a robotics element.) Eighteen percent of the companies were using CAD/CAM equipment and techniques. None of the companies had linked their shop floor computerised equipment electronically to a management information data base, although two were planning this conversion within twelve months of their interview date.

(7) Just-in-time purchasing methods are slower to implement amongst the component suppliers because they do not have the buying 'clout' of larger firms. In many instances, however, they were able to initiate smaller orders, more frequent delivery, longer purchase windows and better-delivered quality by improving their communications with their suppliers. These improved 'downstream' communications included developing a longer term perspective for ordering materials and parts, passing through their knowledge of the long-term build window provided by Prestwick. None of the interviewees had purchased materials under a blanket purchase order provided by Prestwick, although several were aware of this goal in the near future.

Twelve percent of the firms felt that they had implemented JIT purchasing procedures as far as their size allowed. Thirty-eight percent were in the process of adopting just-in-time purchasing procedures, and the remaining fifty percent had not started implementing change.

3.2.2 Identifying the SMEs administrative system changes

The second approach exploring mutually changing relationships was searching for administrative system changes.

Amongst the SMEs, thirty-one percent had decreased their administrative staffing levels, whilst twenty-eight percent had increased the professional qualifications of their staff respectively. These changes are consistent with value-adding concepts of JIT manufacturing and increased productivity, and simplification of the data base using JIT administrative procedures. Upgrading of the administrative staff is necessary to accommodate the more complex administrative systems and data bases. These changes are mirror-image to changes at Prestwick.

Related to procurement changes, forty-four percent of the respondents had begun to review financial data or annual reports of their principal suppliers. This is a mirror-image of the techniques begun by Prestwick and indicates symbiotic change in monitoring the downstream suppliers by the SMEs.

In a similar fashion, fifty percent of the SMEs were requesting some type of financial solvency verification from their suppliers; e.g., Dun and Bradstreet reports, bank references, or similar information. This procedure is one of several necessary to implement single or limited sourcing buying procedures. A financially sound supplier base is essential for JIT purchasing methods to be successful.

In response to a more competitive business environment, thirty-one percent of the interviewees had begun using accounting data to prepare

bids based on variable-costing techniques instead of full absorption costing methods. This change allowed them to submit a more competitive bid in tightly priced situations, where they hoped to secure a particular contract. This change also provides for continual assessment of the production costs and allows for price adjustments, which is consistent with the commensal partnership relationships sought by Prestwick.

Twenty-two percent of the respondents, during the previous three years, had changed their pricing teams to include accounting or finance personnel. Forty-four percent of the firms used accounting data for bid computations, instead of engineering estimates or intuition of the owner or manager.

3.2.3 Correlation between SME and Prestwick changes

Correlation analysis is used as the third approach to mutually changing relationships. Correlation analysis tests for relationships between the known changes at Prestwick and the observed changes at the component suppliers. The purpose of this series of questions, and the subsequent analysis, is to establish similarity (correlation) between the changes at both entities, and mutual beneficiality.

Correlation does not establish exclusive proof of symbiotic changing relationships, but it does establish association. Association between two entities is an indicator of a special relationship; this relationship when coupled with the previous approaches assists in establishing symbiosis between the changes at the various entities. This association is an important factor because the SMEs often operate in several different environments simultaneously, e.g., aerospace, automotive or electronic. Therefore it is important to establish association between changes underway at Prestwick and its component suppliers

Table Nine, below, is not a correlation analysis table, but rather summarizes various correlations found between the SMEs (X axis) and Prestwick (Y axis) changes occurring within the previously designated areas of manufacturing, procurement and administrative systems.

Table Nine - Correlation between SME and Prestwick Changes

SMEs BAe	JIT Prod	TQC	Single Source	Cost Share	Lot Sizes	L/T Re-lations	Partner -ship	Buyer Attitude
Single		.562						
Cost Sh	.602							
Lot Size	.463			.729				
Design		.424	.442	.487	.377			
Relation			.405					
Partner				.389	.394	.680		
Buyer					.381	.495	.777	
Sched	.379			.412	.425		.543	.593

n = 34 significance = + - .349 confidence level = .95

SME JIT Production Changes

The SMEs observed that the changes in production methods were accompanied by cost and risk sharing changes, with a significant correlation coefficient of .602. This observation relates to the Jetstream 41 programme, in which component suppliers were asked to contribute towards design and launch costs. Approximately half of these costs were raised in this manner by Prestwick. Mutual symbiotic change is indicated by suppliers, participating in the cost and risk sharing programme, benefited from long-term contracts, whilst Prestwick benefited from the financial participation and improvements to its production programme.

The Jetstream 41 programme, and to a certain extent the Jetstream 31 build, has been scheduled for smaller lot sizes, normally ten or less aircraft. This has been observed by the component suppliers as a favourable adjunct to just-in-time production with a correlation coefficient of

.463. Mutual symbiotic change is indicated by allowing the SMEs to smooth out their production workloads and shipping schedules to meet a smaller, more frequent build programme. Prestwick benefits by not having to store, handle, insure and pay for inventories exceeding its current build schedule.

The component suppliers' understanding of just-in-time manufacturing changes by Prestwick, and better information flows concerning scheduling procedures, has a correlation coefficient of .379. This symbiosis enhances the SMEs scheduling of their production and purchasing procedures, and facilitates better financial planning.

SME Total Quality Control Changes

An interesting correlation, which is not significant statistically, exists between the changes in quality concerning the two entities. This lack of significance may be partially explained by the governmental regulation influence on quality, which determines SME licensing and certification, and partially diffuses the impact of the major manufacturer upon the component suppliers' focus of change.

The correlation between production changes and observed quality changes is also not significant; this may indicate either belief that government regulations are the main driving force in this area, or that standards are not changing dramatically at Prestwick. The latter observation is supported by informal comments made by the respondents, which verified that standards at Prestwick are consistently high, with no observable change in the actual standards themselves during the previous three years.

The observed change in quality procedures and movement towards single-sourcing is significant, with a coefficient of .562. This correlation may be partially explained by responses from firms selected in the single-sourcing reduction programme, which undoubtedly met or exceeded the highest requirements of both Prestwick and the civil aviation safety

authorities. This may also be partially explained by the firms that did not receive a contract, and were notified to raise their quality standards for future bidding. Symbiotic change is indicated by the incentive of being awarded a single-source contract, which motivates the suppliers to improve their total delivered-product quality. Prestwick benefits by striving for defect-free delivery of components, thus smoothing its assembly and quality assurance process.

Another significant correlation, with a coefficient of .424, is between firms awarded design of sub-assemblies and their observation of changes in quality standards. A partial explanation for this observation is that design authority can be awarded only to those firms that are certified for air-worthiness, which implies that they are meeting the quality standards of both civil and Prestwick authorities. This opportunity positions them to be aware of similar quality changes at Prestwick, thereby enhancing the symbiosis between the two firms.

Internally, the SMEs correlation between quality changes and production changes is sixty-three percent,[62] indicating a strong relationship between the two areas of internal operations. This correlation assists in verifying the literature concerning quality awareness; furthermore, continual improvement is an essential part of changing to JIT manufacturing.

SME Single-sourcing Changes

As discussed in Chapter Four, forty-two percent of the respondents felt that their firms benefited from single-sourcing changes by Prestwick. This statement holds true in situations where the firm was not the successful bidder to the major manufacturer, but was approached to assist in filling the order as a sub-contractor by the successful bidder.

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62. Discussed in chapter five, not part of this table four.

Table Nine above correlates single-sourcing with supplier-design responsibility with a coefficient of .442. This correlation may be explained by the fact that firms awarded design authority and licensing are in a better position for becoming the sole supplier; this contrasts with standard off-the-shelf hardware that can be supplied by any number of qualified firms. Symbiotic changing relationships are confirmed by the benefit to the qualified supplier in becoming the sole source of the designed component, and in some cases, being given complete contract administration for a particular component. In turn, Prestwick benefits from single-sourcing through not having to become design specialists in every component used in the aircraft, also because of a reduction in contract administration costs and time.

The correlation between single sourcing by Prestwick and the SMEs perception of developing a long-term relationship is forty-one percent. This correlation is partially explained by the stated policy of Prestwick to cultivate this relationship with a smaller list of suppliers deliberately. From the SMEs viewpoint, this may indicate a perception of long-term relations by the firms that have successfully become a single-source supplier.

Symbiosis is indicated by the benefits of a long-term relationship for the supplier; for example, open-ended contracts or automatic renewals. Prestwick benefits from improved supplier relationships and reduced contract administration costs. Both of these factors establish mutual beneficiality, one of the necessary elements for changing relationships.

SME Cost-Sharing Changes

The correlation between awareness of cost-sharing attempts by Prestwick and the decrease in build lot sizes is a highly significant .729. This is probably explained by the fact that firms involved to such a degree as cost-sharing, will likely be aware of the total production plan, including

changes in projected build-rates. A symbiotic changing relationship is indicated by the suppliers' ability to smooth their production planning through smaller, more frequent build-sets, and long-term perspectives of the major manufacturer. Prestwick benefits by having financial participation from the component suppliers as well as reduced inventories, storage and administrative costs.

A similar result is reached, for the same reasons as lot sizes, between supplier design and engineering, which has a coefficient of .487 with cost-sharing awareness.

A feeling of partnership emphasis by Prestwick correlates to awareness of cost sharing with a significance of .389. This result is supported by informal comments by the suppliers that question the real durability of this relationship during economic downturns or industry cutbacks. Symbiosis is indicated by a more lasting relationship between the two entities and a sharing of launch and design costs.

Prestwick's attempt to keep suppliers informed about production schedules correlates with cost-sharing by a coefficient of .412. The firms participating in the cost sharing programme were usually awarded long-term contracts and are able to be kept informed about production scheduling. Prestwick has a stated goal of keeping their key suppliers currently informed about their production planning and procurement plans.

SME Lot-Size Changes

The correlation between supplier design responsibility and smaller lot-size is significant with a coefficient of .377. This is understandable when considering the close relationship normally existing between firms' doing design work with a major manufacturer. Symbiosis exists because firms become involved in the build programme over the life of the model; thus firms with design authority are more likely to recognize the advantages of

smaller build-lots. Prestwick benefits from both of these aspects, needing less design skill and receiving deliveries on-time as needed.

The feeling of establishing a partnership relationship correlates with smaller lot sizes with a coefficient of .394.

Another necessary element to implement smaller lot-size is a change in the traditional adversarial buying role to one of mutual trust and cooperation. This relationship correlates with a coefficient of .381, and does indicate the existence of symbiosis between the buyers and marketing personnel involved, with mutuality of benefits for each entity involved.

If a major manufacturer is successful at keeping their suppliers informed about production-build-schedules and changes thereto, it is easier to implement smaller lot sizes. The coefficient of .425 between these two factors is a strong indicator of the symbiosis necessary between the major's production scheduling personnel and the suppliers' marketing and production personnel.

SME Changes to Product Cost

Prestwick has a stated policy of changing to total delivered cost in place of strictly negotiating for lowest prices on contract negotiations. Total delivered cost is defined as cost of the component including insurance, tariffs, taxes, on-time delivery as scheduled and with defect-free delivery. The purpose of changing to total delivered cost is to eliminate the older buying strategy of adversarial purchasing negotiations.

The perceived elimination of the previous adversarial buying attitude by purchasing agents correlates with Prestwick communicating changes to production schedules with a coefficient of .593. This is relevant because reactions to changes in production schedules will be more favourable if there is a perception of cooperation emanating from the major manufacturer.

The symbiosis illustrated by this correlation includes the flow of information between the two entities, and its effects on production build rates.

SME Long-term Relations & Buyer Attitudes

Fifty percent of the respondents felt that Prestwick was attempting to establish longer term supplier relationships favourable to the component suppliers. These longer term arrangements are typically found in open-ended contracts, or contracts for a specific number of build-sets, over the projected life of the aircraft build programme.

In a related matter, forty-five percent of the respondents felt that Prestwick was sincerely establishing a favourable partnership relationship with their suppliers. This is exemplified in design cooperation and longer order times. Twenty-six percent, however, felt that the older adversarial buying methods still existed at Prestwick, to the detriment of the SMEs.

The correlation between firms that observed changes in attitude of Prestwick towards longer-term relationships and changes in attitude of Prestwick's buyers is seventy-eight percent. Both of these observations reinforce the perception of change observed at Prestwick, and an effect upon the relationships with the component suppliers.

To summarize this section, correlation was established between the changes at Prestwick and similar changes at the SMEs in production, quality assurance, procurement and administrative procedures. This correlation or association of these changes assists in establishing that the changing relationships between both entities are symbiotic in nature.

3.2.4 SMEs ranking of their changes

The fourth approach used to establish mutually changing relationships was to ask the SMEs managers to rank the biggest change occurring within their company during the past three years. Their four highest responses to this series of questions were:

(1) production methods, thirty-nine percent,

(2) TQC methods, twelve percent, and

(3&4) JIT delivery and marketing changes, each ranked at nine percent.

(1) Production methods

Forty-seven percent of the respondents were making significant changes in their manufacturing methodology towards just-in-time production methods. Of the fifty-three percent that were not changing to JIT methodology at the time of the interview, fifteen percent were adding CNC machinery to their plant in anticipation of implementing JIT in the future. The remaining thirty-eight percent were distrustful of JIT or did not believe that it was applicable to their particular line of business.

Computer numerically controlled (CNC) machines were the more popular method of preparing for JIT manufacturing changes. Sixty-two percent of the respondents have added CNC equipment to their shop floor within the past three years. This change has benefited the SMEs capacity to respond to smaller orders and improve employee efficiency. One operator can control two or more CNC machines and they can run during the evening hours unattended if properly programmed and loaded with correct tooling and materials.

Thirty-five percent of the respondents were improving their machine set-up times and turn-around times in preparation for JIT manufacturing changes. During walk-throughs of the SMEs facilities several managers showed with pride homemade jigs and tools that they utilised in their operations. In other cases purchased equipment was modified significantly to meet the production needs of the particular SME, or to provide more flexibility of use than the original, unmodified, machine was capable of.

Six percent of the respondents were using various forms of robotics in their manufacturing methodology. The general feeling among the SMEs was that robots are very expensive and demanded intensive computer programming staff support, and had limited applications to the smaller firm. (No attempt was made to verify this conclusion.)

Production lead times, defined as the normal response time from receipt of order to shipping date for civil aerospace products, improved measurably in all categories. For example, firms that shipped within four weeks improved from eighteen percent to twenty-six percent of the respondents. Firms shipping within eight weeks improved from fifty-nine percent to seventy-one percent of the respondents.

(2) Total quality control

The interviewees were careful to explain that the aerospace industry already has existing extremely high quality standards that they are routinely inspected for compliance with. Therefore this series of questions was interpreted as changing towards reaching a standard of shipping defect free product to the major manufacturer, and shifting of quality standards to the component supplier.

Seventy-six percent of the SMEs responded that they were implementing quality assurance methods and employee empowerment techniques attempting to reach this standard. The remainder believed that their standards already exceeded Prestwick's and they did not need to improve upon them. To be frank, the majority of component suppliers do not believe that it is possible to ship defect free products consistently, in spite of the Japanese success stories within Britain.

Forty-eight percent of the firms were changing or adding statistical quality measuring tools onto the shop floor, including Pareto charts at each

work station. The addition of SQC methods was part of their attempt to improve upon their quality assurance programme.

(3) JIT delivery methods

JIT delivery methodology is defined for purposes of this dissertation as smaller lot sizes delivered more frequently than former methods used within the past three years. JIT delivery is considered a necessary component of change towards arriving at a fully integrated JIT manufacturing system. Fifty-nine percent of the interviewees professed implementing JIT delivery in the recent three years. The remaining forty-one percent included situations where delivery was not appropriate (e.g., the major manufacturer picked up the pieces), they were in the habit of shipping smaller lots as completed, or they did not believe the method worthwhile.

(4) Purchasing changes

Exactly half of the interviewees were implementing mirror-image purchasing changes similar to the ones instigated by Prestwick. These changes included upgrading of quality, monitoring of supplier performance, more frequent delivery from their suppliers with smaller lots, and better communication of buying needs. The more frequent reason given for not attempting to change their buying methodology by the remaining fifty percent was size and lack of buying power.

Seventy-four percent of the interviewees have begun to visit their suppliers on a regular basis within the past three years. Fifty-six percent of the respondents have begun rating their suppliers, and sharing (communicating) these ratings with the supplier.

Quality is considered the most important factor in choosing a supplier by thirty-five percent of the interviewees.

On-time delivery reliability by their suppliers was rated highest by twenty-six percent of the respondents, and price by twenty-one percent of the respondents.

Conclusion for level two - the criteria for establishing mutuality of changes between Prestwick and the thirty-four component suppliers interviewed has been established. The first step was to establish that the component suppliers are making similar or mirror-image changes to the changes underway at Prestwick in production, quality assurance and procurement. The second step was to establish administrative changes are being made in a similar manner by the entities involved. The third step to establish mutuality of change was to use correlation analysis between the changes at Prestwick and the changes at the SMEs. All the major system changes did correlate with each other significantly. The last step used the perceptions of the SME management to rank the biggest changes occurring within their companies during the past three years and compare this to the other three findings. The findings from all four of these procedures indicated that mutuality exists between Prestwick changes and those at the SMEs.

3.3 Level Three - Prestwick's Influence upon SME Changes

The third element of the symbiont relationship is to determine if one entity undergoing change has influenced the other entity to make corresponding changes. Specifically, determination of influence by Prestwick upon mirror-image changes by the SMEs is being queried. This influence, even if perceived and not quantifiable, assists in establishing the existence of symbiotic changing relationships between the entities. The amount of influence is often difficult to measure, because it can be pervasive and subtle. However, the SME managers did acknowledge that they were influenced by Prestwick's management and business practices.

Table Ten - Prestwick's Perceived Influence Upon the SMEs

Prestwick's Perceived Influence upon SME Changes	%
(1) JIT manufacturing changes	24%
(2) Total quality control changes	38%
(3) JIT purchasing changes	9%

The SME managers' interviewed believed that Prestwick influenced their decisions concerning manufacturing methodology changes about twenty-four percent. The principle factors were smaller lot sizes and JIT techniques such as cellular manufacturing, CNC machinery and smaller inventories.

Prestwick's influence on SME changes to total quality control procedures was rated at thirty-eight percent. This SME rating is surprising because of the strict quality standards mandated by the aerospace industry in general, not just Prestwick. A partial explanation for this influence may be Prestwick's policy of assisting the SMEs attaining their BSA 5750 rating and the feeling of partnership this assistance engenders. Another explanation may be that JIT manufacturing changes made by Prestwick require defect free delivery, and the firms are rated on this quality attribute in the bid selection process. The shift of responsibility for quality upon the component supplier may also have influenced this perception.

The amount of Prestwick influence upon SME purchasing changes is perceived as about nine percent. Although this appears as a small influence, it must be considered in the context that many of the SMEs are much smaller than their raw materials suppliers, and have little real bargaining power over them.

In addition to table ten above, two other influences from Prestwick affect the analysis of SME change - personnel visitations and management information systems.

On average, Prestwick personnel visit component suppliers about every seventh month, but most of these visits tend to be technical (e.g., engineering or production personnel) and not administrative or managerial. Several comments were made by the SMEs that Prestwick's buyers never come out of their office into the 'real world' to see what problems the suppliers encounter.

The interviewees visit Prestwick, on average, quarterly; sales call and other goodwill efforts are the major reasons. Fifty percent of the respondents reported monthly visits to BAe facilities, either at Prestwick or at other locations. The clear majority of the respondents believed that they had open line of communications with production and engineering personnel at Prestwick. They questioned, however, personnel turnover in the procurement department that created confusion as to who should be contacted about a particular problem or order status.

In an analogous manner, thirty-three percent of the respondents felt that Prestwick had improved its management information systems for better communications with the component suppliers about build schedules, design-changes, and introduction of revised models or entirely new aircraft. These improvements in information systems are supportive to purchasing procedures because they improve the flow of information passing between the entities.

Looking at influences from the component suppliers upon the major manufacturer, it is found only through inference. For example, Prestwick's management stated that it was influenced by changes at the component supplier level, particularly in JIT delivery techniques, but independent verification was not obtained from the SMEs.

Conclusion for level three - the third criterion of perceived influence is deemed to be met because the two major areas involved, manufacturing

and quality assurances, are significant. Purchasing changes and administrative changes are less pronounced, but still perceived to be influenced from Prestwick. Admittedly this is the least indicative area of symbiotic change, but conversations with the managers reinforce the conclusions stated above.

4.4 Level Four - Mutual Beneficiality and Commensality

The fourth level of query establishes the mutual beneficiality of the changes occurring at both entities and which benefits form a commensal relationship between the entities.

Table Eleven - Mutual Beneficiality and Commensality

Beneficiality to Prestwick:	
Average amount of sub-contracting	60 %
Other benefits - not increasing physical plant or equipment, downsizing flexibility, less capital required, improved performance and cash flows.	
Beneficiality to the SMEs:	
Overall positive effect of changes upon their companies	47 %
Respondents seeking more aerospace contracts	88 %
'Downstream' changes by SMEs upon their suppliers:	
Decreasing their supplier base	29 %
Requiring increased quality	41 %
Improving communications	35 %
JIT delivery or other procurement changes	29 %

3.4.1 Beneficiality to Prestwick

Beneficiality at Prestwick's level was established by finding that approximately sixty percent of the build is sub-contracted outside of BAe. This amount of sub contracting, coupled with several managers' statements that this was deemed more important to them even though they had in-

house expertise and capability, is deemed sufficient evidence of beneficiality to Prestwick.

Prestwick's managers stated that they perceived benefits from contracting out as much as sixty percent of their build in not having to increase physical plant and equipment, flexibility in types of materials or products to use, downsizing considerations if sales should decrease, and less capital required. Many of the managers at Prestwick are long-term employees who have seen large cyclical changes, termed 'boom or bust again' by the aerospace industry; they prefer the flexibility provided by contracting out components over increasing capacity during the boom periods.

Prestwick directly benefits from the mirror-image changes made by their suppliers because of improved performance in production, quality, delivery and administrative changes. These improvements in quality and reliability directly benefit the build procedure at Prestwick because the parts do not need modification or adjustment and can be placed into the aircraft as planned.

In addition to the benefits listed above, Prestwick saves overhead expenses and improves cash flows if the SMEs are able to do design and engineering services, stock materials, and offer flexibility in their manufacturing times and rate of delivery. All of these techniques mean that Prestwick has a small inventory on hand, contributing toward JIT manufacturing goals.

3.4.2 Beneficiality to the SMEs

The Prestwick changes in production, total quality controls, single sourcing, supplier design, long-term relationships, partnership developments and scheduling procedures were favourably received by the SMEs.

Forty-seven percent of the SMEs stated that, overall, the changes queried had a positive effect upon their company. The managers recognized that these changes, when viewed from their entirety, facilitate the manufacturing process, that betters the commensal relationships. Another forty-one percent believed the effects were neutral, which arguably means that at least they were not detrimental. Several of the respondents who expressed neutrality stated that it was too early to establish how beneficial the changes were, because they were still in-process or not in-force long enough to measure the benefits. The temptation to ask if they 'expected' the changes to be beneficial was resisted; the researcher deemed this too vague of a question that would lead to speculation on the respondent's part.

A second approach was used to measure beneficiality and commensality of the changes. The respondents were asked if they were seeking more, same, or less aerospace type of work. A significant number, eighty-eight percent, responded that they were seeking 'more'. Given that changes at Prestwick had already been established, and that changes were being made by the SMEs, then seeking more aerospace work is perceived as an indicator of beneficiality and commensality from the changes.

A third approach was selected to triangulate the mutual beneficiality of the observed changes. Several questions were asked of the SMEs to determine if they were requiring their suppliers to implement similar changes. The reasoning behind this series of questions was that it would be doubtful that an entity would request a supplier to implement a change that the entity believed was not beneficial.

A sample of these downstream supplier changes includes sourcing changes, quality assurance, communications and procurement. Twenty-nine percent of the SMEs were decreasing their supplier base, preparing for single-sourcing or at least limited sourcing of materials, parts and

components. Forty-one percent were requiring (or at least requesting) increased quality and quality assurance procedures from their suppliers. Thirty-five percent of the SMEs were striving to improve communications with their suppliers and instill two-way confidence in the communication process. Twenty-nine percent were making other procurement changes, JIT delivery, smaller quantities, free of defects, etc., from their suppliers.

Spontaneous comments received during the fieldwork, which actually comprises a fourth verification, indicated mutual beneficiality: both firms are being driven to become more competent; "change forces better communications, both ways; change sharpens customer service, which benefits both of us; our response time must be faster than our competitors; and Airbus Industrie is forcing the British Aerospace Industry to change for the better, the ultimate effect will be good for all of the U.K." (Paraphrased from various SME interviews.) These comments, although not measurable nor quantitative, do assist in the overall evaluation of the perceptions of SME management. This is an example of the benefit of semistructured questions asked during a multiple case study approach to gathering research data.

Indirect observations and measurements of mutual beneficiality not included in table eleven above include:

(1) Length of employment in the current industry by the respondent averaged 18.9 years, which can be interpreted as very stable. If changes that are occurring at the workplace are deemed non-beneficial personnel will often leave. Therefore, the argument could be made that these changes did not create disenchantment, and therefore interpreted as beneficial by experienced managerial personnel.

(2) Twenty-eight percent of the respondents were increasing their staff's professional qualifications, which implies the changes required higher quality staff. An increase in quality can be argued as an

indicator of a beneficial situation, for the expenditure would probably not be made if it was non-beneficial.

(3) Twenty-two percent of the respondents were increasing their administrative staff sizes, which reflects growth of their firms and increased complexity of their operations, both of which affected by beneficiality of change. If the changes were not perceived as beneficial, firms would probably decrease staff size in preparation for a downsizing.

Conclusion for level four - beneficiality at Prestwick's level was established by finding that approximately sixty percent of the build is sub-contracted out and other direct benefits to plant, inventories, cash flow and flexibility. Forty-seven percent of the SME managers believed that the changes were mutually beneficial, eighty-eight percent are seeking more civil aerospace contracts, a significant number are implementing similar changes downstream with their suppliers and their spontaneous comments seemed to favour symbiotic change. In addition, the overall response to Prestwick's changes in the important areas of production, quality, procurement and administrative changes were favourable. (Table six above.)

3.5 Level Five Conclusion - Existence of Symbiotic Changing Relationships

The research findings of the four levels of inquiry discussed above are sufficient to establish symbiotic changing relationships as defined in this dissertation. The SMEs did observe changes (as designated) at Prestwick, they are making mirror-image changes in their respective areas of operation, they did perceive direct and indirect influence from Prestwick, and they believe the changes are mutually beneficial. This conclusion is further developed and discussed in chapter seven, research conclusions.

An argument can be made that this sample is from the 'survivors' of the changes at Prestwick. This argument is accepted as possibly true. However, the conclusions are not made irrelevant because of this argument. This dissertation questions the existence of symbiotic changing relationships, not the reasons for the change. Therefore, even if the sample is drawn from the survivors of a Prestwick change, it does not alter the validity of the findings. This is analogous to the occasional gleaner fish that is accidentally eaten by its shark host. The conversion into inadvertent victim for the smaller fish does not negate the symbiotic relationship between the two creatures.

4.0 CHAPTER CONCLUSION

The small and medium sized component suppliers are in the process of changing their production methods, their marketing and purchasing techniques, and to a lesser degree, their management information systems.

These changes are symbiotic with similar changes made by the prime manufacturer, British Aerospace, Prestwick. Specific symbioses are found between changes in production-methods, lot-sizes, vendor-liability, quality-controls, vendor-design, single-sourcing, and cost-sharing.

In addition to the symbioses found, the SMEs' management believed that Prestwick's changes in quality-control, single-sourcing, supplier-design, development of long-term relationships, and striving for mutual partnership feelings were beneficial to their firms.

The SMEs negatively rated Prestwick's changes to cost and risk-sharing, smaller lot sizes, supplier liability changes, buyers' attitudes, and vendor payment procedures.

The managements of the SMEs state that the four most significant endogenous changes in their operations during the past three years included changes in production methods and procedures, procedural changes in purchasing of materials and supplies, marketing methodology changes relating to the majors, and changing to just-in-time delivery methods.

From the SMEs perspective, the four highest observed exogenous changes in the aerospace industry during the past three years included:

(1) the procurement policies of the majors changing to single or limited sourcing of the majority of build-items in lieu of the multiple-sourcing practices traditionally used;

(2) increased quality demands as governmental rules were modified to allow supplier certification, as well as higher expectations from the airframe assemblers for defect-free delivery of parts and components;

(3) increased technology as new materials and demands were placed upon the component suppliers; and

(4) more outsourcing of parts and components as airframe assemblers sought to grow through increasing their external supplier base instead of increasing internal capacity.

During the past three years specific changes have been made by the SMEs. For example, forty-seven percent of the respondents implemented some type of JIT manufacturing method, fifty-nine percent delivered smaller lots more frequently, seventy-seven percent improved their quality-control methods and sixty-two percent installed CNC or other computerised equipment.

Another finding from the research is that many of the component suppliers to the aerospace industry are also active in the electronic and automotive industries.

The SMEs are making procedural changes downstream with their suppliers. Twenty-nine percent are decreasing their supplier base, which is a step towards limited-sourcing. Single sourcing is still viewed with apprehension and occasionally, with outright distrust. SMEs' management is pressuring suppliers to insure that in-coming deliveries are on-time, with forty-seven percent reporting increasing success. Thirty-five percent feel that communication with their suppliers is improving, and their suppliers are becoming better at keeping the SMEs informed of supply situations and price changes. Twenty-two percent of the SMEs are rating their vendors on an internal management accounting programme.

This chapter presented the results of the research from the component supplier's perspective. The next chapter summarizes the total research findings and answers the four research hypotheses.

CHAPTER SEVEN INDEX - **RESEARCH CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS**

CHAPTER SEVEN - **RESEARCH CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS**

1.0 INTRODUCTION

The purpose of this chapter is to draw appropriate conclusions from the results of the semi-structured interviews, questionnaires administered, literature search and personal observations conducted during this dissertation's research.

1.1 Research Objectives

Chapters one and two established that Western businesses are reacting to increasing competitive pressures and procedural changes from newly developing countries and advanced industrialized countries, particularly Japan, China, Korea and several Southeast Asia countries. The pressure from these 'Pac-Rim' countries, coupled with the emerging economic power of the former Eastern European bloc countries is resulting in adaptation of manufacturing, procurement and quality assurance changes by both major manufacturers and their component suppliers. This in turn raises the issue of simultaneous or similar changes taking place between a major assembler and its component suppliers. If these changes are occurring simultaneously, the question arises how to describe the changes in a business context, especially from a relational viewpoint. The traditional and modern economic theories are examined to describe this simultaneous change; the natural science phenomenon of symbiosis is also considered to determine if there is symbiotic changing relationships occurring between the partners.

The primary research objective of this dissertation is to determine the existence, or non-existence, of symbiotic changing relationships between

Prestwick and a sample of thirty-four of its component suppliers. The criteria for defining symbiotic changing relationships include symbiosis, mutual beneficiality, and commensal aspects of relationships.

This research objective was examined using three operational areas involving known changes at Prestwick, and subsequently investigated at the component supplier level:

1.1.1 manufacturing methodology and quality procedures - including JIT production methods, cellular manufacturing, computerisation of equipment, total quality control, quality assurance, open-bin parts stockage, and reduction of inventories;

1.1.2 purchasing-marketing interface - changes toward single-sourcing, JIT delivery, supplier design, long-term relationships, partnership development, concentration on total delivered price, supplier visitation, and more accurate projections of build-schedules; and

1.1.3 changes in the supporting administrative information systems - payment procedures, supplier and staff certification, cost and risk participation, product liability and product costing methods.

1.2 Symbiotic Changing Relationships

In 1991 Prestwick introduced a twenty-nine passenger aircraft model designated the Jetstream 41. BAe is using this model introduction as a catalyst for making major changes in manufacturing, quality assurance, procurement and administrative systems at Prestwick. This new model introduction provided an opportunity to observe if Prestwick's suppliers were emulating changes being made at Prestwick, and if so, were they influenced by Prestwick personnel and/or policies. These observations enabled the researcher to draw conclusions concerning the research objectives about

symbiotic changing relationships between Prestwick and thirty-four of its component suppliers.

The term 'symbiotic changing relationship' is defined by modifying the original biological definition used by Gotto (1969) to meet the differing business objectives.[63] Symbiosis is modified to mean that two or more business organizations can exist together in a normally competitive environment without either seeking advantage over the other (not preying on the other participant) to obtain mutually beneficial economic and monetary needs and engage in commensal activities for the building of aircraft.

Commensal activity is modified to acknowledge that within the civil aerospace industry the airframe assembler normally obtains the sale of the aircraft, however the materials suppliers and component makers participate in the benefits of building the aircraft (literally dining at the table together) with the major assembler concerning the aircraft build.

Changing relationships are introduced into the definition to recognize that to compete and survive in the modern business world the older manufacturing methods are not practical. Many exo- and endogenous factors, ranging from foreign competitors to new technology, mandate changes at all levels by the participants in the aircraft build hierarchy. (Todd and Simpson, 1986, Newhouse, 1983, McMillan, 1990.) These same factors also imply that the relationships between the purchaser/marketeer must change in reaction to the same external and internal forces acting upon the participants. In a like manner, the administrative support systems must also change to meet the informational needs of the new procedures. (See Aviation Week and Standard and Poor's articles.)

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63. A symbiotic changing relationship is defined as the changing relationship between two or more businesses that are changing specified procedures in a commensal association because of mutual benefits and reacting to various exo- and endogenous influences.

2.0 RESEARCH CONCLUSIONS (SUMMARY)

To test the modified symbiotic changing relationship definition, it first must be shown that Prestwick is undergoing change. In fact, Prestwick was found to be undergoing significant changes in manufacturing, quality assurance, procurement and administrative procedures within the previous three years to this research. This finding was verified by Prestwick management's statements, intensive interviews with personnel at all levels, third party verification from their suppliers, and personal observations of the researcher during plant tours and interviews.

This research finding of change at Prestwick is important to establish because the modified natural science definition of symbiosis is dependent upon the supporting factors of mutuality, commensality and beneficiality. To be mutual, both entities should be undergoing change, to be commensal both entities should be changing together and thus have incentive to improve their relationships, and to be beneficial the changes must enhance both entities operating efficiencies and/or profits. These supporting factors assist in identifying symbiotic changing relationships between one entity to another - termed either similar changes or mirror-imaging in this dissertation. (Gotto, 1969.)

The next step after identifying changes underway at Prestwick was to follow through with observations at the SME component supplier level. It was determined by observation and pre-fieldwork analysis that four levels of inquiry would be necessary to establish symbiotic changing relationships at the thirty-four SME interviewees.

The four levels or research objectives established were:

2.3.1 Research Objective One - Level One

'Have the changes by Prestwick in manufacturing, quality assurance, purchasing, and administrative support systems been observed by a sample of its SME component suppliers?'

A series of questions were designed to determine if the SME managers have actually observed one or more of the changes underway at Prestwick. The SMEs' managers make frequent visits to the Prestwick site and often are in telephone contact with various Prestwick personnel, so they are in a position to observe any changes which may be implemented.

2.3.2 Research Objective Two - Level Two

'Have the SME component suppliers that observed designated changes at Prestwick made similar changes in their procedures and methodologies?'

This series of questions searched for mirror-image or similar changes by the SMEs during the same time-frame established above. The semi-structured interview technique utilised during the fieldwork established which changes were being implemented. The responses from the SME management was verified through personal observations during plant tours and opportunistic discussions by the researcher with line personnel at the SME sites. Plant tours were frequently offered, and always accepted, and in many ways were as valuable in collecting information as the interviews. The line personnel seemed to enjoy having their work viewed by a non-manager and were usually quite open and willing to discuss pertinent matters.

2.3.3 Research Objective Three - Level Three

'Is there perceived influence from Prestwick upon the component suppliers concerning the decision to make similar (mirror-image) changes in manufacturing, quality assurance, purchasing and management information systems procedures or methodologies?'

If the SMEs were making similar or mirror-image changes to Prestwick's, their underlying motives for making the changes were queried. In particular, the managers were asked for their perception of the degree of influence over their changes exercised by their dealings with Prestwick. If the SMEs were not making mirror image changes they were queried to determine if there was implied or implicit influence or pressure to make specified changes. In several cases managers stated that although they have not started making a particular change they knew that had to in the near future to compete for future Prestwick contracts.

2.3.4 Research Objective Four - Level Four

'Are these changes made by Prestwick and a sample of its suppliers perceived as mutually beneficial and commensal?'

This series of questions were designed to augment the modified definition of symbiotic changing relationships to establish mutual benefits and commensality from the changing relationships. As in level three, these responses were perceptions and not exact quantifiable measurements, however the respondents did not hesitate in giving their viewpoints. This area of questioning is an example of the richness derived from using semi-structured questionnaire techniques.

2.3.5 Conclusion - Level Five

If each of these four levels of query are answered in the affirmative, than a conclusion can be argued that symbiotic change exists between Prestwick and thirty-four of its component suppliers. This conclusion is limited to specific changes in manufacturing and production procedures, total quality assurance changes, procurement methodology, and management information systems implemented by Prestwick and the thirty-four SMEs interviewed.

2.4 Executive Summary - Research Conclusions

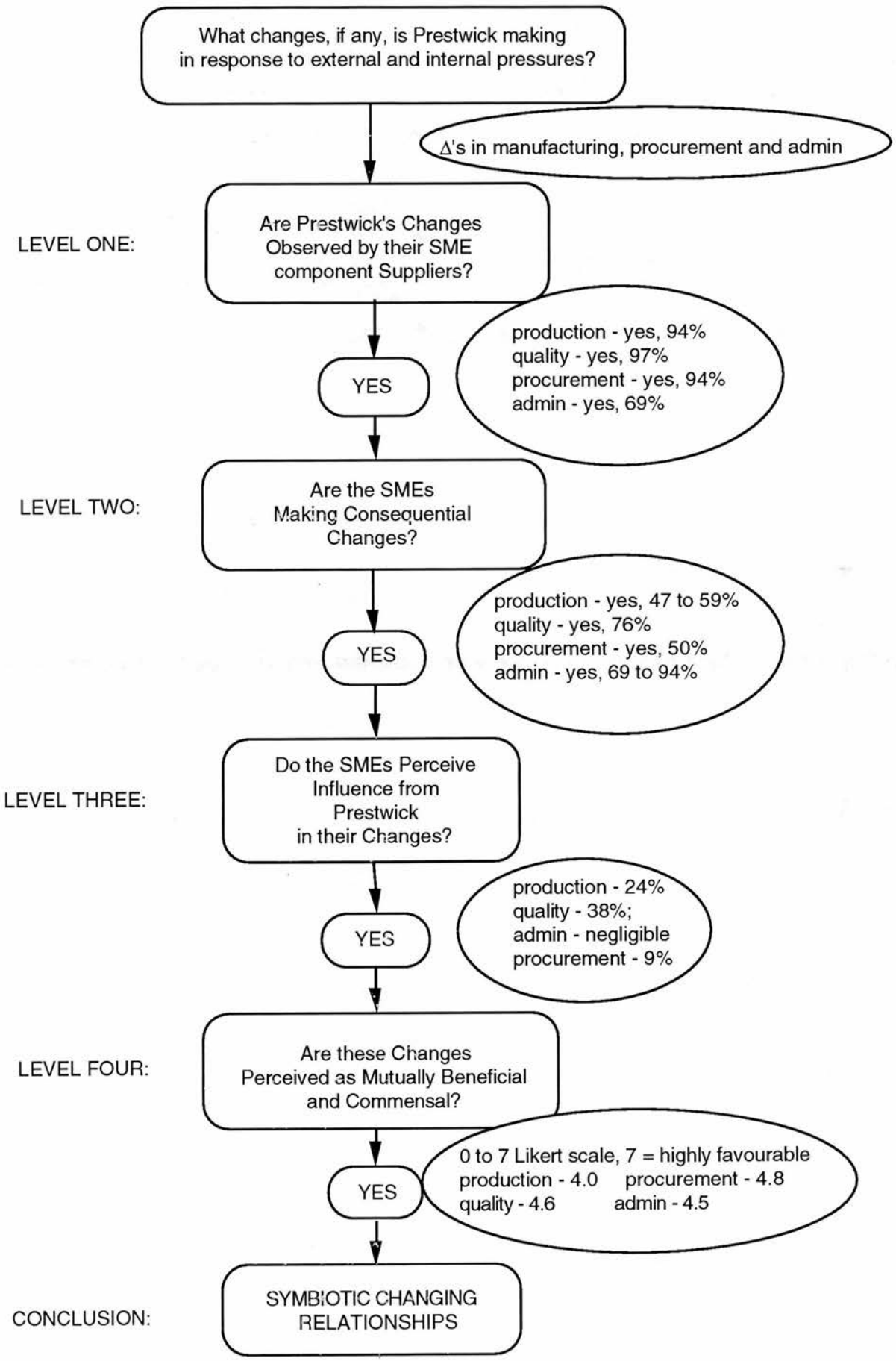
The major manufacturer, Prestwick, was found to be making certain changes in their manufacturing methods, quality assurance programmes, procurement procedures and administrative support systems. These changes were deliberate and by design implemented with the introduction of a new model aircraft, the Jetstream 41. The changes were in-process and had been instigated within the previous three years from dates of interview. Some changes were not fully implemented as of the interview dates. (1991).

The thirty-four small and medium sized component suppliers to Prestwick were interviewed and many were found to be making similar or even mirror-image changes as Prestwick's. Attempts were made to determine the existence of influence, mutual beneficiality, and symbiosis between the changes underway at each entity, and their effects upon relationships. The research results indicate that the changing relationships were symbiotic between Prestwick and its thirty-four component suppliers.

The methodology used to establish this finding were personal interviews with top management at both Prestwick and the SMEs; observations and walk-throughs of the Prestwick site and the component supplier's facilities, administering a semi-structured questionnaire, correlation analyses of the questionnaire answers, and third party observations attesting to various conditions necessary for symbiotic change to take place. Every attempt was made to follow up on opportunistic situations and conversations that added depth or richness to the information received.

The research conclusions are illustrated below using figure one from chapter one with a summation of the findings superimposed upon the various levels.

Figure One - Results of Symbiotic Changing Relationships



3.0 LITERATURE SUPPORTING THE CONCLUSIONS REACHED

3.1 Economic Theories

The relevancy to modern industry of neoclassical economic theories popularised by Keynes, Galbraith and others, is questioned by this researcher. These trade theories purport that materials or products move relatively freely between countries whilst the basic factors of production do not. In the aerospace industry, primarily because of governmental involvement, the basic factors of production move relatively freely between countries. This has been established even amongst the few major assemblers, with new countries coming on-line, e.g. Japan, China, Israel, Romania and Brazil. The primary component and raw material suppliers are global, with almost every country that has an industrial base participating in the civil aerospace market.

Williamson, in his transaction cost analysis theory, uses three classifications of asset specificity which are strongly applicable to the civil aerospace industry. His three classifications, discussed in chapter two, are:

(i) site specificity

Civil aerospace firms are domestically oriented to their mother countries. Although their procurement and sourcing policies are global, the actual assembly of aircraft takes place within a few sites.

(ii) physical asset specificity

Many of the civil aerospace dies and tooling are product specific and not interchangeable between models within the same firm, nor with other firms within the industry. Several commentators observe that aeronautical engineers are notorious for designing odd-shaped parts for aircraft when standard, off the shelf components may be acceptable. These custom parts are specific for one model only.

(iii) human asset perspectives

The steep human learning curve is well documented and becomes part of the profit projections within the civil aerospace production planning process for each new model.

The transaction cost theory explains why it is more difficult for a newcomer to displace an existing supplier to a participating partner in the transaction. Although this argument is not unique to the civil aerospace market, it is important because of the degree of intensity to which it is applied in this industry. This theory reinforces the long-term relationships and cooperation between participants, but does not adequately explain the reasons for symbiotic changing relationships.

The interaction approach to industrial marketing, advocated by Biemans, Ford and others, assists in understanding the dynamics of the interrelationships involved between the civil aerospace customer and the prime manufacturer. This theory emphasizes the changing relationships as the parties move through the various stages of a business transaction, and places a premium on long-term aspects for strategic and business planning.

3.2 Forces Acting upon Western Industry

3.2.1 Japanization of Western business

Oliver and Wilkinson discuss this adaptation by British industry at length in their book, as well as policy implications and relations. The authors stress the importance of achieving a 'good fit' of the Japanese practices to Western businesses, and not expecting these adapted practices to be a package for automatic success. In summary, the authors feel that the Japanization of British industry is a response to the problems encountered in international competition. This response is appropriate for the civil aerospace industry, which is being threatened by newcomers from Japan

and other Pacific rim countries, as well as narrowing, but intensifying, competition between Boeing, McDonnell-Douglas and Airbus Industrie.

Oliver and Wilkinson discuss six sets of production procedures, these have been emulated by British aerospace firms in some instances: (1) group work teams, (2) flexible working conditions, (3) quality circles, (4) statistical process control, (5) total quality control, and (6) JIT production practices.

It should be noted that the latter four of the six production procedures emulated above are being implemented at Prestwick. For example, Prestwick's management stated that they are implementing cellular manufacturing because they believe they have a responsive and flexible workforce.

3.2.2 Global competition

Michael E. Porter believes that seven themes have emerged in international competition. Porter's themes, along with related research notes, include:

> *"1. There is no one pattern of international competition nor one type of global strategy. ...Sometimes an international industry is nothing more than a collection of largely separate domestic industries.*

(Research note - this theme is descriptive of the civil aerospace industry. The major manufacturers are separate domestic industries that operate on an international scale in their marketing, procurement and manufacturing methodologies.)

> *2. The globalization of competition has become the rule rather than the exception by 1986. ...The particular forces driving globalization as well as the resulting patterns of competition vary widely from industry to industry.*

(This theme is descriptive of the new entrants into civil aerospace. Within the past two decades countries are coming onto line with domestic airframe assemblers - China, Romania, Brazil, Israel, among others.)

> *3. The nature of international competition has changed markedly in the last two decades. ...The changes in international competition have affected every functional area; and historical ways of doing things, as well as research based on earlier periods, are no longer sufficient to guide today's strategic choices. Many firms are prisoners of their history, however, which makes new lessons difficult to learn.*

(Perhaps the most obvious change has been the various consortiums forged within the civil aerospace industry. Various major players will joint-venture a particular aircraft or engine model to meet a market segment and be ferocious competitors on another model.)

> *4. Coordination among increasingly complex networks of activities dispersed worldwide is becoming a prime source of competitive advantage. In each functional area of a firm, whether it be finance, marketing, production, or R & D, the need to coordinate activities in different countries has become an imperative.*

(The scarcity of certain exotic aerospace materials and the increasing cost of aircraft production has made strange 'bedfellows' of international consortiums. Noticeably amongst these are Japan, China, Boeing and Airbus Industrie. Apparently, the breakdown of Eastern European states will add to this list during 1993 and 1994.)

> *5. Governments are increasingly both promoting and protecting against global competition, requiring new approaches to government relations. ...In the process, governments are also competing among themselves to attract foreign firms.*

(Governments are active in civil aerospace in several aspects - marketing, financing, requiring local parts content, or attracting manufacturing facilities. Most noticeable example of this activity is the Japanese governmental

agency, MITI, which actively promotes aerospace activities amongst Japanese manufacturers.)

> *6. Global strategies frequently involve coordination with coalition partners as well as among a firm's own subsidiaries. ...The firms who can make international coalitions work will have an important edge in international competition.*

(Civil aerospace firms are involved in this concept, as evidenced by negotiations underway between Boeing and BAe and Deutsche Aerospace. The latter two firms are partners in Airbus Industrie, but are holding discussions in 1992 with Boeing concerning a new large aircraft model.)

> *7. Implementing a global approach to strategy requires a difficult organizational reorientation for many firms. ...The solutions arise as much from attitudinal changes, education, and organizational processes as they do from formal reporting relationships."*[64]

(This is illustrated in civil aerospace by the difficult decisions major assemblers are having to make concerning the amount of technology to be transferred in exchange for financial and technical assistance from new entrants. Airbus Industrie and Boeing are independently considering adding a Japanese partner and manufacturing overseas for the first time in their histories. Rolls Royce made a decision in the mid-eighties to use Japanese engine manufacturers for several of their models.)

In an article in The Tacoma Morning News Tribune, July 22, 1991, several machine shop owners were describing the current competitive environment in the aerospace industry. The owners were quoted as saying that price, quality and deliveries were make-or-break criteria to remain as suppliers to Boeing and other manufacturers. They believed that too many machine shops have entered the market due to the boom years of the 1980's, and now competition has forced profit margins to become 'razor

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64. Michael E. Porter, ed., 'Competition in Global Industries', (Boston: Harvard Business School Press, 1986), pp. 5-7.

thin'. They foresee a 'buyers market' for several years, which will cause many of the weaker shops to fail.

Competition has forged interesting new ventures for traditional aerospace companies. According to a Wall Street Journal article on October 1, 1991, Boeing was awarded a $1.6 billion U.S. Army contract to build a vast computer network over eleven years. A month earlier, The Seattle Times announced a successful IBM contract from the British Royal Navy for $2.5 billion to build forty-four Merlin anti-submarine helicopters extensively loaded with electronic gear. Even though both of these contracts are for the military, it is interesting to note the changing faces of new competition within the aerospace industry from non-aerospace companies, and the diversification efforts of aerospace companies to obtain business outside of their primary industry.

3.2.3 Global implications

Civil aerospace companies are global in their sphere of operations. For example, airframe and aero-engine assembly, supplier base, customer (airline) base, raw materials, and government regulations are global in their location, endo- and exogenous effects, and ultimate influence upon the civil aerospace industry. (Newhouse, 1983, Reed, 1973, Standard & Poor's, 1992.)

Airframe manufacturing competition is global in nature with major assemblers in North and South America, Western and Eastern Europe, Australia, the Near-East, and the Far-East. (Todd and Simpson, 1986.) The component and material suppliers are more geographically disbursed than the assemblers, with virtually every country that has modern industrial capacity having some participants in the aerospace industry.

The customer base is world wide and is gradually shifting from advanced industrialised countries to newly industrialised countries, as the

NIC's civil air-fleets are upgraded and modernised. Consequently, civil aerospace marketing strategies and emphasis must reflect this global shifting of customer base. This global shifting is illustrated by a statement Boeing's CEO Frank Shrontz made: "...Asian-Pacific nations are buying more airplanes and supplying more parts for Boeing and other firms. The twenty-three nations that make up the Pacific Rim have the fastest-growing economy in the world and they collectively represent a huge part of aerospace sales."[65]

The spare parts or replacement market for aircraft often is global, because used aircraft from a fully industrialised country may be sold to a newly industrialised country that is emerging into the aerospace business, most notably in state-owned airlines. This global secondary parts market is supported in theory by Cannon et. al., 1988, who emphasize the importance of distribution policies in marketing and international competitiveness.

The literature suggests that the larger of the small and medium-sized component suppliers are more likely to engage in exporting or other forms of internationalisation. (Withey, 1980; Schlegelmilch, 1983; Roy & Simpson, 1981.) This finding is important to the SME component suppliers because of the broader implications of civil aerospace being global in nature yet applicable to them regardless of size.

James (1990) argues that off-shore placement of manufacturing creates a 'hollowing-out effect' not only upon the firm, but, also affecting national considerations. He believes that this creates a skills void, which he terms as 'atrophy'. James suggests that this skills atrophy causes firms to lose their competitive edge and skills base, further spiraling them into competitive disadvantage. This philosophy is diametrically opposed to the

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65. Tacoma, The Morning News Tribune, October 1, 1991, p. B14.

out-sourcing policies espoused by the airframe assemblers, who source off-shore considerable percentages of an aircraft build.

Both James and McMillan's research are pertinent to aerospace assembly as it now exists. The major assemblers use extensive outside component manufacturers. They justify their decision to outsource primarily on economic reasons. Most of the major assemblers, however, maintain a minimal in-house operation in each of the areas to retain their basic skills, and also to place implied pressure upon the suppliers to keep their prices in line.

3.3 Governmental Influences

The governments of many countries are deregulating their airline routes, or already have deregulation in place. First, deregulation changes the number of airline customers available to the airframe assemblers; and second, it changes the type of equipment purchased by the existing traditional markets. For example, connecting airlines have different equipment and capacity needs than a long-distance intercontinental carrier. These new customers open a window of opportunity for smaller airframe manufacturers to capture part of the market not previously available to them, or for existing manufacturers to offer new types of aircraft. (See Aviation week, 6.20.88 p.61-71; Deregulation and Airline Competition, OECD, 1988.)

The normal concepts of governmental assistance in export promotion, tax incentives, technology and innovations support, import - export financing, payment guarantees, and marketing assistance are not completely descriptive. Other factors which must be considered, especially by the civil aerospace industry, are balance of trade effects, national pride, national defence, and the large outlay of capital to bring a new product into production. (Todd and Simpson, 1986; Reed, 1973). It is not surprising,

when considering all of these factors, that governments are intimately involved with the civil aerospace industry either directly or indirectly. (Doz, 1986)

Reed (1973) describes the Royal Aircraft establishment at Farnborough as having a primary responsibility of working with the military and civil sectors in R & D and problem-solving. A secondary function of Farnborough's is to collaborate with other countries in joint civil and military R & D efforts. Joint collaboration usually produces negligible cost savings, but given the large amount of capital necessary for developing a new engine or airframe, the overall savings can be substantial for participating countries. In many cases, one country could not face these enormous start-up costs alone, at least from the political acceptability and social policy viewpoint.

Eiteman and Stonehill (1986) discuss the implications of financial assistance by governments. The principal governmental plans are financing through an Export-Import banking system and through complete or partial guarantees of financial paper or loans. Governments may also offer special incentives for private export funding corporations by sharing the risk of non-completion or non-payment, forfeitures, or even financing. France and Germany have been active in financing arrangements for Airbus Industrie aircraft sales, often to criticism by their American competitors. For example, on March 6, 1992, Delta Airlines announced a purchase of nine Airbus A310-300s for its international routes. A Boeing spokesman commented that Boeing could not match the Airbus prices because of their government subsidies amounting to hundreds of thousands of dollars.

A long-standing feud has materialized between Boeing Commercial aircraft group and the governments involved with Airbus Industrie. Boeing accuses governmental interference in various forms of assistance: outright grants of monies, favourable tariff terms, favourable financing arrangements

and preferred buying for state owned airlines. Boeing vice-president for planning and international development, Larry Clarkson, told members of the U.S. Senate finance Committee that government subsidized financing to Airbus Industrie could cost Boeing $20 billion in lost sales within the next eight years. Clarkson accused the European governments of deciding not to abide by the Large Aircraft Sector Understanding agreement, which prohibits government-subsidized financing. He cited the consortium giving America West airlines $100 million in cash to be used as a down payment on Airbus aircraft purchases. (Tacoma News Tribune, June 3, 1992, p. E1).

3.4 Strategic Planning

Porter (1980) asserts that "...the essence of formulating competitive strategy is relating a company to its environment." (p. 3; see also Bradley, 1985). He postulates five competitive forces which drives a firm to compete in its industry, and, within its underlying economic structure:

(1) Threat of entry - new entrants from other countries, e.g., aerospace work encouraged by MITI for heavy industries in Japan; or through new competitors within the firm's country. The SMEs interviewed believed almost unanimously that competition is increasing from new firms becoming British Aeronautics Authority (BAA) certified within Britain, and from new countries competing for aerospace work including Japan, Korea and China.

(2) Threat of substitution - this threat has limited application in the aerospace industry but is certainly existent. Substitution can be in forms of alternative transportation or types of materials or technology. High speed trains, view telephones, even fax machines can substitute for air travel, thus affecting civil aerospace. New composite materials are replacing the traditional aluminium for airframe coverings, computerised controls

replacing hydraulics and cables, modular interiors replacing traditional seating, and others. The traditional component suppliers must face this threat and react to it in an appropriate manner.

(3) Bargaining power of buyers - the SMEs interviewed expressed considerable vulnerability to buyers. Many of the SMEs believe that the expressed goal of improving communications by Prestwick's top management is not being implemented by middle management and that pressure is still exerted purely on pricing considerations.

(4) Bargaining power of suppliers - as explained in later chapters, the majority of the SMEs believe that they have a small amount of influence over their suppliers, most of whom are large multi-national corporations. This has been partially overcome by Prestwick negotiating blanket purchase orders, with authority given the SMEs to draw from this pool. The second perspective is the SMEs viewpoint as a supplier; that they have little influence or bargaining power over Prestwick's buyers, and are thus in a lesser position. As a group the suppliers do have considerable power over a major assembler, but loosely organized trade associations etc. do not often give the suppliers power to yield.

(5) Rivalry among current competitors - Porter believes that competitors are mutually dependent. Mutual dependency is defined by Porter as competitive moves by one firm having noticeable effects upon other firms competing in that industry. The implementation of single (or rather limited) sourcing policies by Prestwick has increased this competition amongst the supplying SMEs. An interesting collaboration has resulted amongst the SMEs, however, in that the firms not winning the contract may often be asked by the successful bidder to assist in filling the order. Single sourcing implies, amongst other factors, that the successful bidder have capacity to supply the entire build programme and provide surge capacity as

needed. This implication, coupled with the need to reserve capacity for other products and growth, often forces the successful SME to sub-contract portions of its build to other qualified and certified suppliers. These suppliers are often competitors on other products and may have been competing for this contract.

3.5 Change

The question naturally arises about which business objectives are currently 'driving' the participants in the civil aerospace industry to make changes, and how these drivers are different (if at all) from other industries.

This research finds that the motivational drivers are frequently common with other industries, but have different degrees of emphasis placed upon them. For example, total quality control is considered extremely critical in the aerospace industry, but it may be classified as very important in the electronics or automotive industries.

The aerospace industry is noted for its continual change in procedures, technology and materials. To accommodate change, aerospace organisations must provide a systematic display of activities, categorized according to the individual needs of that firm. Stoner and Freeman (1992) believe that organizational culture nurtures change by shaping the attitudes of the employees and the firm's method of dealing with changes in its environment.

Manufacturing Changes

Lubben (1988), Brown and Mitchell (1991), McMillan (1990), Ackoff et. al., (1984), and James (1990) discuss manufacturing changes by general industry, but their premises are applicable to civil aerospace changes.

Smith, in an article in Aviation week and Space Technology discusses three innovative business arrangements utilised to cope with

increased competition. He found that airframe manufacturers are: teaming with their component suppliers via long-term contracts, co-development with potential aircraft customers in aircraft design, and, programme partnerships with other aerospace contractors. The first of these business arrangements illustrates the changing relationships between major manufacturers and their component suppliers.

Prestwick depends upon its suppliers and sub-contractors to furnish the components so that they can build aircraft; the SME component suppliers depend upon the larger manufacturers to sell aircraft and thereby provide a demand for their particular component, part or sub-assembly that they manufacturer.

The more frequently appearing manufacturing changes in civil aerospace are just-in-time (JIT) assembly techniques, cellular manufacturing methodology, total quality assurance, kanban (inventory pull) method of parts movements, outsourcing of components, and more offshore assembly and component manufacture. (Simonson, 1968; Todd & Simpson, 1986; Newhouse, 1983; and research interviews with Prestwick and individual SMEs.)

McMillan (1990) concludes that U.S. civil aerospace manufacturers have replaced vertically integrated operations with increased use of subcontracting, and have given suppliers more design and production responsibilities, both of which are JIT techniques. He cites Boeing's efforts to implement statistical quality controls (SQC) in their suppliers' manufacturing methodology and to involve them in the aircraft build, beginning with the early design process.

Production and global procurement methods are changing in response to increased competition by fewer aircraft assemblers. For example, each new aircraft model forges a new consortium of major and

minor component suppliers who may be competitors on other aircraft models. Another example of changing procurement methodology is the complete sub-contracting of major assemblies and components. A commonly found example is the complete assembly of wings or fuselages, which often are assembled half-way around the world, implying a sharing of technology and systems on a truly global scale. (Airbus Industrie, Boeing.)

Lubben (1988) discusses the reversal of the post-war practices of separating quality assurance from production to returning quality responsibility to the production function. The more obvious quality changes in civil aerospace are requiring no-defect delivery of purchased parts and components, air-worthiness certifications by personnel involved in production, vendor guarantee of warranties, and worker empowerment to stop the assembly process upon detection of a problem.

Burt (1989b), Gitlow et. al., (1987), Walton (1986), O'Lone (1990), Rees and Rigby (1988), and Lubben (1988) discuss changes applicable to total quality management or assurance.

Purchasing Changes

The significant changes in civil aerospace purchasing methodology include decreasing the supplier base in striving to achieve single or limited sourcing, longer-term relationships with suppliers, paperless purchase orders, open-ended contracts, contracts for the build life of an aircraft, and JIT delivery of the components in smaller build sets. The civil aerospace industry, in conjunction with most other industries has traditionally utilised an adversarial buying relationship with its suppliers. The main objective of this relationship was to achieve the cheapest price for the best product, utilising as many suppliers as necessary.

Heinritz and Farrell (1981), Segal (1989), Dion et. al., (1990), Ashton, (1986), Evans and MacKenzie, (1988), Giunipero, (1990), O'Neal, (1989),

and Pearson and Gritzmacher, (1990), discuss purchasing methodology changes. Hayward, (1988), and the Standard and Poors' and Aviation Week references directly discuss civil aerospace changes.

A review of a typical director of purchasing position description through the 1980's reveals that they were responsible for maintaining good relations with other department heads within their organization, but no mention was made of outside supplier relationships. (Heinritz and Farrell, 1981.) This research is pertinent to the civil aerospace industry, where buyers have been trained in the traditional adversarial multiple-sourcing methodology, and appear to be resisting changing over to the newer concepts. Traditional aerospace purchasing department managers were oriented towards price as the principal consideration for negotiation, with quality assumed to be high.

Before entering into a long-term supplier relationship, O'Neal advocates care in customer selection for the supplying firm. The effects of JIT upon supplier/customer relationships, more careful selection of a major manufacturer or other customer was given emphasis by forty-one percent of his respondents. O'Neal's research is applicable to the component suppliers because their changing relationships with Prestwick must be based on long-term considerations for maximising results and development of partnership-like relationships.

The aerospace industry differs from the automotive industry in its location of suppliers. Automotive companies prefer to have their suppliers clustered around them and capable of providing JIT delivery every two hours if necessary - as Nisson does in Sunderland Borough. The large assemblers do not feel this geographical grouping of suppliers is necessary and perhaps not even desirable, given the global sphere of civil aerospace operations. (Oliver and Wilkinson, 1988).

Changing Relationships

A different form of alliance between management and their customers (exogenous influence) is the use by aircraft manufacturers of customers assisting in the design of new aircraft. (Smith, 1990, discussed under the customer section of the relationships section later in this chapter.)

Porter and Fuller (Porter, ed. 1986) refer to joint-ventures as coalitions. They define coalitions as formal, long-term alliances that combine various aspects of their businesses, but do not result in a merger. They found in their research that coalitions are becoming more strategic, often encompassing global competition, instead of the more traditional tactical market access or technology transfers. The authors link strategic coalitions with Porter's value chain in any of the five areas of activities. The appropriate activity for the civil aerospace coalitions commonly found are the operating activities (production and R&D). The authors argue that coalitions involve potential costs - coordination, erosion of competitive position, and creation of an adverse bargaining position. The aerospace industry is finding a fourth cost also, the technology transfer allowing new entrants into the industry.

Many authors include customer relationships with quality management as the two are juxtaposed with the final product. For this dissertation, customer relations are treated separately because the civil aerospace customers have unique characteristics. The commercial airlines are often as large, if not larger, than the airframe and engine manufacturers. They are also proactive in design specifications and market needs, have clearly specified product quality standards, and marginal brand loyalty. Many airlines are connected to the state, and thus impose nationalistic considerations into the marketing procedure.

Komatsu heavy equipment manufacturer in Britain sends its engineers into its suppliers to improve their production methods and quality controls. With a sixty percent local content requirement for foreign firms operating in Britain, the suppliers must deliver on time and in expected quality to the Japanese firms based in Britain. (Oliver and Wilkinson) The aerospace industry, including Prestwick, is beginning to practice these same techniques. Prestwick will send engineers, production experts, and other technical assistants to selected suppliers if they begin running into problems. Currently this is on a 'as-requested' basis, with the initiative coming from the suppliers. However, Prestwick's quality assurance, production and engineering personnel may become more proactive and make assistance visits as they observe problems developing. Prestwick is willing to share accounting and management information programmes also, but they could not remember a request for this type of assistance as of the interview dates. (Interviews with Prestwick's production and quality assurance personnel.)

Financial Changes

Brimson (1988), Cocker (1989), Grinyer et. al., (1990), Beaujon and Singhal (1990), Borden (1990), Innes and Mitchell, (1989), Johnson and Kaplan, (1987), Maskell (1986), Murphy and Braund(1990), and Dent (1990) discuss changes in administrative support systems.

The primary financial changes have been: vendor participation in start-up costs, delaying vendor payments until delivery of aircraft, vendor build responsibility for segments, vendor participation in research and development costs, creative financing for aircraft sales, and longer-range planning for capital purchases and operating revenues.

A marked decrease in governmental financial support in the European aerospace industry has been another significant financial change.

The recession of the 1970's revealed the perilous financial condition of many of the world's airframe and engine manufacturers. (Todd and Simpson, 1986; Newhouse, 1983) Many companies were forced to merge or cease doing business, and governments were forced to take economic actions to protect their national interests. Even the present industry leader, Boeing Commercial Aircraft Corporation, was near bankruptcy in 1970. (Newhouse).

The civil aerospace industry is capital-intensive and utilises many expensive parts and components. For example, a set of engines can total as much as fifty percent (or even more) of the total cost of construction of an aircraft. Landing gear and cockpit electronics are other major, expensive components. Each of these factors contributes to cash-flow management problems. Porter (1980) regards the need to invest large amounts of capital as one of six barriers to entry for new firms. Yosikawa, Innes and Mitchell (1989) describe a functional analysis approach to cost management that is pertinent to this section in that it addresses the identification of major components, suggests alternatives for improvements and recommends an interdisciplinary approach across functional lines and authority.

The manufacturers and industry analysts query where the airlines will obtain the money to finance the purchase of £260 billion in new aircraft orders already on the books. The airlines are in their worse recession since World War II, according to a Financial Times article on June 13, 1991. Even spare parts have felt the impact of the recession. Rolls Royce stated in an interview in the Financial Times on March 8, 1991 that the current difficulties of the airlines have decreased their highly profitable spare parts business significantly.

4.0 INFORMATION SUPPORTING RESEARCH CONCLUSIONS

Before searching for symbiotic changing relationships, it must first be established that Prestwick is making significant changes that can be observed and emulated by its component suppliers.

This research finds that Prestwick has initiated changes in its production, quality assurance, procurement and administrative procedures within the previous three years. Chapter five relates the following changes currently underway at Prestwick:

(1) manufacturing - JIT production methods, cellular manufacturing techniques, quality assurance programmes, total quality control, culture of quality, build-lot size decreases, open-bin parts stockage on production line;

(2) purchasing - JIT delivery scheduling, total delivered cost buy decisions, single or limited sourcing, external and internal communication improvements, long-term contracts, development of feeling of partnership, suppiier design responsibility;

(3) administrative - development cost-sharing, extension of payment terms, wider distribution of a twelve month build schedule, and product cost analyses.

Once these facts were determined, the search for similar or mirror-image changes at the component supplier level could begin; the purpose of which is to test the modified physical science definition of symbiotic changing relationships.

Changes being made by the prime contractor are commensurable with the discussions in the current literature about changing methodologies and procedures in manufacturing, procurement and administrative support systems in general. Thomas and Bennis, (1972), Stoner and Freeman,

(1992), Bolwijn and Kumpe, (1990), and Porter (1986) all address changes necessary by modern businesses, and the various influences acting upon these changes.

For an analysis of these references please see chapter two. It is interesting to note that the research did not uncover procedures or policies being changed by either Prestwick or the component suppliers that were contradictory to the current literature.

4.1 Level One of Results of Symbiotic Changing Relationships

The first level of figure one queries if the SME component suppliers are aware of changes at Prestwick. This research establishes that many of the thirty-four component suppliers queried have observed significant changes being made at Prestwick within the previous three years.

Table One - Prestwick's Changes Observed by Their SMEs

Prestwick's Changes Observed by their SMEs:	%
JIT manufacturing methodology changes	94%
Total quality assurance changes	97%
Procurement changes	94%
Administrative changes	69%

n = 34

The individual results for each type of change are shown in table one above. In addition to these results, eighty percent of the SME respondents were simultaneously aware of all three areas of change at Prestwick - manufacturing, procurement and administrative systems.

This high percentage of simultaneous awareness is not unexpected, because the change areas are interconnected and observable. Multiple observations of changes are facilitated whenever they are in close proximity to each other or related in function, both of which occurs at Prestwick. This high awareness of Prestwick's changes may also be an indicator of

symbiotic relationships developing because of the partnership goals discussed earlier.

Conclusion for level one - The high percentage of SME observations are deemed sufficient to determine that the SMEs are aware of changes underway at Prestwick in manufacturing, quality, procurement and administrative systems.

This conclusion was verified by questioning SME management, observation of their procedures indicative of awareness (e.g., smaller ship sets delivered more frequently), or reviewing the actual changes made by the SMEs within the prior three years that were similar or mirror-image to Prestwick's changes.

4.2 Level Two of Results of Symbiotic Changing Relationships

The second level of figure one queries if the SMEs are making consequential changes, either similar or mirror-image, to Prestwick's during the same three year time period. The answer was determined by identifying which changes the SMEs were making, comparing these changes to Prestwick's, and then testing for correlational relationships between these changes and Prestwick's. The correlation analyses assists in establishing relationships between the two different sized entities.

4.2.1 Identifying changes by the SMEs

The first task is to determine if the SMEs were making changes in the three designated areas of operation. The timing of these changes is also important to establish symbiotic changing relationships, thus an arbitrary three-year time period was established. Table two below summarizes the changes that the SMEs are making currently or that were initiated within the previous three years from date of inquiry:

Table Two - Manufacturing Changes by the SMEs

SME CHANGES	Stage of Implementation		
Type of Change	Not Started	Partly In-stalled	Oper-ational
JIT Production Methods	52 %	30 %	18 %
JIT Delivery Procedures	41 %	21 %	38 %
Total Quality Control Culture	24 %	44 %	32 %
Statistical Quality Control Techniques	53 %	26 %	21 %
Faster Machine Set-up Times	64%	18 %	18 %
CNC Equipment, CAD/CAM Methods	38 %	24 %	38 %
JIT Purchasing Methods	50 %	38 %	12 %

n = 34

Table two summarizes only the changes at the SMEs that are similar or mirror-image to the changes at Prestwick, thus attempting to isolate the symbiotic changes taking place.

Three of the more significant changes are in quality, computerization and JIT delivery methodologies. The quality and delivery changes, amounting to seventy-six and fifty-nine percent respectively, are responsive in part (mirror-images) to the changing manufacturing requirements of Prestwick. The sixty-two percent changes toward CNC equipment is partially in response to production changes at Prestwick, and also reflects the modernization of the component supplier industry evident amongst the survivors still in existence.

JIT purchasing changes have reached the fifty percent level, which reflects the avowed better communications between the SMEs and their suppliers. As previously commented upon, this factor also reflects the lack of purchasing power (or 'clout') because of the relative size of the SMEs compared to the material suppliers.

The lesser response to JIT production changes, forty-eight percent, partially reflects the traditional resistance to utilising mass production

techniques and change. However, it does reflect a significant improvement within the SME component suppliers in the aerospace industry because batch sizes are small when compared to automotive or electronic industry orders. Thus a forty-eight percent change towards JIT or similar manufacturing techniques is indicative of a response to Prestwick's and other major manufacturers desires to decrease batch sizes even further (to ten in the case of the Jetstream 41 model).

The forty-seven percent change to using statistical quality control techniques, which in reality is part of total quality control culture, is interpreted as primarily a use of Pareto charts on the production line or statistical sampling techniques for quality assurance, with lesser use of equipment deviation monitoring capabilities as the SMEs convert over to CNC equipment.

The least active change is converting existing equipment to faster machine set-up times through machine modifications, workflow routing or operator training. This procedure is typical of the resistance to the JIT manufacturing techniques of limited production runs using multi-purpose equipment. However, a thirty six percent change level in this area may be considered above average.

In summary, mirror-image or similar changes are being made by the SMEs sampled in this research. Their percentage of change ranges from seventy-six percent that are making quality assurance changes to forty-eight percent that are making JIT production or manufacturing changes.

4.2.2 Correlations between SME and Prestwick changes

The second task concerning level two is to ascertain if the changes have a consequential relationship with the changes being undertaken at Prestwick. Establishing a consequential association between the changes at both entities lays the ground work for determining perceived influence

from one entity to another - in this instance associating Prestwick's perceived influence upon subsequent changes at the SMEs.

One method of determining association is to use correlation analysis, which looks at the relationships existing between two or more factors. Various factors at both Prestwick and the SMEs were tested for association and some were found to be statistically significant. The significant findings are summarized below in table three.

Table three illustrates that there are significant correlations between Prestwick changes and those at its component suppliers interviewed. Several of the stronger correlations are in production, quality assurance and the development of partnership relationships over the long-term, which complement the definition of symbiotic change used in this dissertation. The SMEs also placed emphasis on the changing scheduling procedures and buyer attitudes at Prestwick, which are also indicative of symbiotic change.

Table three is <u>not</u> a correlation analysis table, but rather summarizes appropriate results derived from correlation analyses as explained in chapter five. The Y axis represents changes underway at Prestwick, the X axis changes underway at the component suppliers.

Table Three - Correlations Between SME and Prestwick Changes

SME BAe	JIT Prod	TQC	Single Source	Cost Share	Lot Sizes	L/T Re-lations	Partner -ship	Buyer Attitude
Single		.562						
Cost Sh	.602							
Lot Size	.463			.729				
Design		.424	.442	.487	.377			
Relation			.405					
Partner				.389	.394	.680		
Buyer					.381	.495	.777	
Sched	.379			.412	.425		.543	.593

n = 34 significance = + - .349 confidence level = .95

Prestwick's policy change towards single sourcing has a strong correlation to quality changes at the SMEs, probably reflecting their perception that quality is a criteria for selection. Prestwick's proposals for sharing pre-launch and development costs correlates with the SMEs JIT production method changes, reflecting supplying of demo models, parts for testing and certification. Prestwick's change to smaller lot sizes, ten aircraft per build, correlates with production changes at the SMEs and their efforts towards cost sharing. Many SMEs perceive that smaller lot sizes have forced inventories downward upon them, making the SMEs responsible for stocking the parts until the next lot of aircraft is built.

Prestwick's change to having their suppliers participate in the design process correlates with total quality control, single sourcing, cost sharing and smaller lot sizes at the SMEs. The SMEs participating in the design would have input into the overall quality and be more aware of necessary controls. In most cases, the design supplier will likely be the single source provider for the part, so a strong correlation is not surprising. Cost sharing is a likely result of the design process, with the supplier supplying design and engineering services as part of their package of goods and services. Further, the SME involved in the part design should be aware of the smaller number of aircraft (ten) per build and thus more likely to program smaller production runs at their facility.

Prestwick's desires to build stronger relationships with their suppliers and a feeling of partnership between the entities correlates strongly with single sourcing, cost sharing, lot sizes and long-term relationships at the SME level. The explanation for these relationships (as well as changing buyer attitudes and scheduling procedures by Prestwick) parallels previous discussions above and are not repeated here. A comment is appropriate about the desire to establish long-term relationships and partnership

feelings at the SME level however, because this assists in establishing mutual beneficiality and commensality discussed later in this chapter.

Conclusion for level two - This research finds that a clear majority of the thirty-four component suppliers to Prestwick interviewed are making changes in their manufacturing/quality, purchasing/marketing, and administrative systems. These changes are similar or mirror-images to the changes being made at Prestwick, which assist in establishing symbiotic changes between the two entities indicating mutual beneficiality.

4.3 Level Three of Results of Symbiotic Changing Relationships

The third element of the symbiont relationship is to determine if one entity undergoing change has influenced the other entity to make corresponding changes. Specifically, the determination of influence by Prestwick upon mirror-image or similar changes by the SMEs is being queried. This question was answered by asking the management of the SMEs their perceptions of the amount of influence Prestwick exerted over their changes; the relationships then were examined and tested through correlation analysis.

4.3.1 Prestwick's perceived influence upon SMEs

The SME managers were questioned about the extent of Prestwick's influence upon their changes, even if perceived and not quantifiable, to establish the existence of symbiotic changing relationships between the entities. (Axinn, 1988, discusses managerial perceptions.)

Table Four - Prestwick's Perceived Influence Upon the SMEs

Prestwick's Perceived Influence upon SME Changes	%
JIT manufacturing changes	24%
Total quality control changes	38%
JIT purchasing changes	9%

In this research, influence of the major manufacturer upon the component suppliers has been detected. Because of the several industries that almost all of the SMEs operate within, the degree of influence is not large, averaging over twenty percent. However, this is not deemed to invalidate the significance of the influence because of the very fact that the SMEs do operationalise in several industries, therefore any perceived influence is deemed important.

4.3.2 Correlation analyses

Table five summarises various significant correlations between the perceived influence from Prestwick and changes in methodology at the SMEs.

Table Five - Prestwick influence Significantly Correlating with SME Change

SME CHANGES BAE INFLUENCE	Production Changes	Delivery Changes	Setup Time Changes	CNC Equipment Additions	Purchasing Methods	Statistical Quality Controls
Production Chgs	.613					
Delivery Changes		.473	- .409	- .508		
Quality Assurance			.380			.360
Statistical Control	.488					.570
Setup Times		.864	.591			- .391
CNC Equipment		- .863	.561	.582		- .721
Purchasing Mtds					.802	

Significance = + - .349 Confidence interval .95 CNC = computer numerically controlled

The perceived influence from production changes correlates strongly with the actual changes underway in production amongst the SMEs. This indicates a significant degree of influence from Prestwick upon the production changes at the SMEs.

The BAe influence upon delivery changes correlates with actual SME delivery changes, setup time changes and addition of CNC equipment. This

indicates a need to modernize equipment and delivery techniques to meet the more frequent, smaller lot size delivery requirements of Prestwick. This same conclusion follows for the quality assurance, statistical control, setup time, CNC equipment and purchasing methods influence upon similar changes at the SMEs as illustrated in table five. (See Bilkey, 1985, for support.)

All of the correlations are strongly indicative of relationships between the influence from Prestwick and the actual changes at the SMEs. This indicator supports the comments and perceptions made by the SME management concerning their understanding of influence from Prestwick.

Conclusion - This research found influence exerted from Prestwick upon the changes at its component suppliers. The specific areas of influence is upon mirror-image changes made by the component suppliers which correlate with similar changes at Prestwick. Some of this influence is perceived through inference and observations by the SME management, and part of it is because of quality requirements imposed by Prestwick and the industry/government complex. Correlation analysis indicates the probability of an eighty percent correlation between purchasing methodology changes, sixty-one percent correlation between production changes, and forty-seven percent between administrative changes concerning the two different sized entities.

4.4 Level Four of Results of Symbiotic Changing Relationships

The fourth level questions the existence of mutual beneficiality between changes occurring at both entities, and which benefits are commensal in their association. (see Burt, 1989b; Bourantis, 1989; Modic, 1988.)

4.4.1 Beneficiality to Prestwick

Beneficiality at Prestwick's level was established by finding that approximately sixty percent of their build is sub-contracted outside of BAe. This amount of sub-contracting, coupled with several managers' statements that out-sourcing was deemed important to them even though they had in-house expertise and capability, is deemed evidence of beneficiality to Prestwick. The Prestwick managers believe that sub-contracting out a large percentage of build gives them more flexibility during times of downsizing, and relieves pressure on limited manufacturing facilities at Prestwick.

Prestwick directly benefits from the mirror-image changes made by their suppliers because of improved performance in production, quality, delivery and administrative changes. In addition to these benefits, if the SMEs are able to do design and engineering services, stock materials, and have flexibility in their manufacturing times and rate of delivery, Prestwick saves overhead expenses and improves cash flows.

4.4.2 Beneficiality to the SMEs

The Prestwick changes in production, total quality controls, single sourcing, supplier design, long-term relationships, partnership development and scheduling procedures were all favourably received by the SMEs.

Forty-seven percent of the SMEs stated that, overall, the changes queried had a positive effect upon their company. Another forty-one percent believed the effects were neutral, which arguably means that at least they were not detrimental. Several of the respondents who expressed neutrality stated that it was too early to establish how beneficial the changes were, because they were still in-process or not in-force long enough to classify the benefits as beneficial or otherwise.

A second approach was used to measure beneficiality and commensality of the changes. The respondents were asked if they were seeking more, same, or less aerospace work. A significant number, eighty-

eight percent, responded that they were seeking 'more civil aerospace work'. Given that changes at Prestwick had already been established, and that changes were being made by the SMEs, then seeking of more aerospace work is perceived as an indicator of beneficiality and commensality of change.

A third approach was selected to triangulate the mutual beneficiality of the observed changes. Several questions were asked of the SMEs to determine if they were requiring their suppliers to implement similar changes. The rational behind this series of questions was that it would be doubtful that the SME would require a supplier to implement a change unless the requestor believed it was mutually beneficial.

A sample of these downstream changes include sourcing changes, quality assurance, communications and procurement changes. Twenty-nine percent of the SMEs were decreasing their supplier base, preparing for single-sourcing or at least limited sourcing of materials, parts and components. Forty-one percent were requiring (at least requesting) increased quality and changes in quality assurance from their suppliers. Thirty-five percent of the SMEs were striving to improve communications with their suppliers and instill two-way confidence in the communication process. Twenty-nine percent were making other procurement changes, JIT delivery, smaller quantities, free of defects etc. from their suppliers.

Conclusion - The research findings indicate mutual beneficiality between the changes at Prestwick and the mirror-image changes at the SMEs. Forty-seven percent of the SMEs believed the mutual changes had a positive effect upon their companies. In addition, forty-one percent were neutral about the beneficiality but acknowledged the mutuality. The argument for beneficiality was reinforced by finding that the SMEs were implementing these changes with their suppliers - 'downstream changes'.

4.5 Level Five of Results of Symbiotic Changing Relationships

The results of the four levels of inquiry previously discussed above are deemed sufficient to establish symbiotic changing relationships between the two different sized entities as defined in this dissertation: the SMEs observed changes (as designated) at Prestwick, they are making mirror-image changes in their respective areas of operation, they perceived direct and indirect influence from Prestwick, and they believe the changes are mutually beneficial. The various levels of inquiry were considered necessary as a totality to establish symbiotic changing relationships, although individually they would not prove or disprove symbiosis. The findings at each of the four levels agreed with the current literature, keeping in mind that there was not a direct source applicable to changing relationships within the civil aerospace industry. The indirect references support the findings in accordance with the procedures and policies found at the prime contractor and its component suppliers.

The conclusions drawn above from each level of inquiry lead themselves naturally into an overall conclusion for the entire research objective - does symbiotic changing relationships exist between a major manufacturer and a sample of its thirty-four component suppliers?

The conclusion is reached that aspects of symbiotic changing relationships do exist between Prestwick and thirty-four of its component suppliers concerning manufacturing, purchasing and certain administrative changes. These changes are in-process in many instances and will probably change again before this dissertation is completed, but the symbiosis between the two different sized entities is deemed to exist, especially when the changing relationship between them is viewed utilising

the symbiotic definition. As previously mentioned, the detail of the actual research findings are discussed in chapters four, five and six.

To illustrate this general conclusion, a table summarizing how each of the thirty-four participants responded to the four major issues queried is presented below:

Table Six - Participants' Summary

Respon-dent #	Level One: Δ's Observed by SME's?	Level Two: Consequential Δ's by SMEs?	Level Three: Influence From Major?	Level Four: Δ's Mutually Bene-ficial?	Conclusion: Evidence Sufficient?
1	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Partial	Yes	Yes
3	Yes	Yes	Partial	Yes	Yes
4	Yes	Yes	Partial	Yes	Yes
5	Yes	Yes	Partial	Yes	Yes
6	Yes	Yes	Partial	Yes	Yes
7	Yes	Yes	Yes	Yes	Yes
8	Yes	Yes	No	No	Neutral
9	Yes	Yes	Partial	Yes	Yes
10	Yes	Yes	Partial	Yes	Yes
11	Yes	Yes	Partial	Yes	Yes
12	No	Yes	No	No	No
13	Yes	Yes	Yes	Yes	Yes
14	Yes	Yes	Partial	Yes	Yes
15	Yes	Yes	Partial	Yes	Yes
16	Yes	Yes	Yes	Yes	Yes
17	Yes	Yes	Yes	Yes	Yes
18	Yes	Yes	Yes	Yes	Yes
19	Yes	Yes	Partial	Yes	Yes
20	Yes	Yes	Yes	Yes	Yes
21	Yes	Yes	Partial	Yes	Yes
22	No	Yes	Yes	Yes	Yes
23	Yes	Yes	Yes	Yes	Yes
24	Yes	Yes	Yes	Yes	Yes

25	Yes	Yes	Partial	Yes	Yes
26	Yes	No	Partial	Yes	Yes
27	Yes	Yes	Partial	Yes	Yes
28	Yes	Yes	Yes	Yes	Yes
29	Yes	Yes	Partial	Yes	Yes
30	Yes	Yes	Yes	Yes	Yes
31	Yes	Yes	Partial	Yes	Yes
32	Yes	Yes	Partial	Yes	Yes
33	Yes	Yes	Yes	Yes	Yes
34	Yes	Yes	Partial	Yes	Yes
Total Yes	32	33	13 - yes 19 - partial	32	32

In only four of the thirty-four respondents were there negative findings in any of the four levels of the test. In only one case was there a majority of negative findings. These results indicate very strong support for the existence of symbiotic relationships between the manufacturer and its suppliers.

4.5.1 Level five conclusion

The conclusion is reached that symbiotic changing relationships do exist between Prestwick and thirty-four of its component suppliers concerning manufacturing, purchasing and certain administrative changes. These changes are in-process in many instances and will probably change again before this dissertation is completed, but the symbiosis between the two different sized entities is deemed to exist, especially when the changing relationship between them is viewed utilising the symbiotic definition. As previously mentioned, the detail of the actual research findings are discussed in chapters four, five and six.

To support this conclusion, table seven below summarizes the individual levels' conclusions as a percentage of component suppliers that have observed changes at Prestwick; the percentage of component

suppliers that have made various defined changes in the past three years, or, had been in the process of making these stated changes; and, the amount of influence that Prestwick has had upon its component suppliers in making a decision to change.

The Y axis of the table specifies particular applications where these changes were observed to occur at Prestwick, thus establishing the need for change at the SME level.

Table Seven - Symbiotic Changing Relationships Between Prestwick and Its Component Suppliers

Prestwick method undergoing change	% of SMEs that have observed changes at BAe	% of SMEs making similar changes	% of Prestwick's Influence upon SME changes
a. JIT Production & Delivery	94 %	Production 47 % Delivery 59 %	24 %
b. Total Quality Control	97 %	76 %	38 %
c. Single or Limited Sourcing	94 %	50 %	9 %
d. Smaller Lot Sizes	91 %	35 %	11 %
e. SME Design or Engineering	94 %	62 %	24 %
f. End User Product Liability	91 %	94 %	n/a
g. Reduced Stock Levels	97 %	29 %	n/a

n = 34

4.5.2 Discussion of table seven:

a. Just-in-time production and delivery changes observed at Prestwick, and mirrored by similar changes by its SME component suppliers, include:

(1) Ninety-four percent of the SMEs interviewed observed significant change at Prestwick in both manufacturing methods and in delivery size lots and schedules within the previous three years. Prestwick production personnel stated that the capabilities and performance of their component suppliers had an influence upon the type of change and the degree of manufacturing performed in-house by Prestwick. As Prestwick builds a more sophisticated supplier base, it tends to outsource more of the complicated component manufacturing and become more of an assembler.

(2) Correspondingly, forty-seven percent of the SMEs had made significant changes in their production methods during the previous three years. The primary changes were smaller lot sizes, computerisation of shop floor and design equipment, and more sophisticated job control and costing systems.

(3) Fifty-nine percent had changed their method of delivering their product to Prestwick changing to JIT delivery techniques. The primary change was smaller lot sizes, delivered more frequently. Another change, closely allied with a culture of quality, was more rapid delivery response to requests for replacement of defective parts or components.

(4) The SMEs stated that the amount of Prestwick influence over their changes in production and delivery methods was twenty-four percent for each method. Although this response is an opinion and not a precise quantitative measurement, the percentage is significant and does indicate reaction to change influenced by the major manufacturer.

b. Total quality control and development of a corporate culture of quality changes at Prestwick and mirror-image changes implemented or instigated at the SMEs:

(1) Ninety-seven percent of the SMEs observed changes in quality- control methods at Prestwick within the past three years. Because of the nature of the aircraft industry with high quality standards already existing, the observations are more procedural in nature. The crux of the major change was a

shift in determining quality responsibility, rather than a significant increase in the standards themselves. The biggest procedural change was the downsizing of inventory by Prestwick, which implies fewer components being delivered. Smaller parts and materials inventories places a premium on quality being right the first time. The important impact upon the SMEs has been that the product had to be delivered defect-free the first time.

(2) Seventy-six percent of the SMEs had made changes in their total quality controls within the previous three years. In some cases this entailed meeting the British Standards Authority (BSA) 5750 standard, and in other cases, procedural changes discussed in Chapter Six. The primary changes have been to place more responsibility on the production line and employees identifying errors or defects early. As part of the corporate culture of quality, Prestwick is attempting to instill employee attitudes of not allowing defects to go forward, employee authority to stop production, and multi-tasking of jobs.

(3) The suppliers have been making production quantity attitude adjustment, which is directly related to quality attitudes. The prevalent attitude was to make large batches and 'just a few extra' in case of quality defects. The change has been toward the concept of total quality control throughout the manufacturing process. Although few component suppliers used the term 'culture of quality' in describing their attempted changes, the net effect is similar in that they have been attempting to infuse employee quality-consciousness throughout their operation.

(4) The interviewees estimated that the amount of Prestwick influence on their changes in quality was thirty-eight percent. As in the case of production changes cited above, this is an opinion, not a precise measurement. The perceived influence does, however, indicate a strong reaction to change and therefore, symbiosis.

c. Single, or limited, sourcing changes, longer-term contracts, rating of suppliers, and other sourcing changes observed at Prestwick and implemented in a mirror-image manner by the SMEs:

(1) Ninety-four percent of the SMEs observed significant changes in sourcing methods and procedures by Prestwick within the previous three years. The primary changes observed were:

i. reducing the supplier base by single or limited sourcing procedures;

ii. less free issue of raw materials, castings or barstock;

iii. rating of Prestwick suppliers for performance and delivery standards; and

iv. rating the suppliers during the traditional annual quality inspections.

(2) Fifty percent of the component suppliers made corresponding changes in their purchasing methods, primarily in reducing their supplier base. Other noticeable changes have been rating of the SMEs' suppliers, attempting better communication with their suppliers, and providing annual estimates of purchase requirements.

(3) The interviewees' opinion of the extent of Prestwick's influence upon their purchasing decisions was nine percent. Although this influence is not significant, it may be misleading in that the SMEs selection of suppliers have been limited. Many of the SMEs were not comfortable with the concept of single-sourcing, and felt that they had limited influence over their suppliers who were normally much larger. All of these factors may partially explain the low rating of influence given Prestwick.

(4) As mentioned, most of the component suppliers are smaller than the companies from which they purchase; this size differential reduces the amount of influence they exert over their supplier base. Prestwick anticipated buying problems that the component suppliers might encounter, and has been arranging with the major materials suppliers for annual blanket

purchase orders. The SMEs have authority to purchase from this Prestwick set-aside. This affirmative action indicates a symbiont relationship flowing from the needs of the suppliers to the major manufacturer, thus emphasising the non-directional nature or causality of symbiosis.

d. Changes to smaller lot-sizes or build-sets, implemented by more frequent delivery of components or parts, by Prestwick, and corresponding mirror-image changes at the component supplier level:

(1) Ninety-one percent of the component suppliers observed that Prestwick was purchasing smaller lot sizes or numbers of build sets during the previous three years. From Prestwick's perspective, they could implement cellular manufacturing and JIT concepts as their supplier base became more adept at delivering smaller lots more frequently. Prestwick's primary change has been to decrease its build- set from thirty aircraft to ten, with corresponding downstream decreases in delivery of components.

(2) The reaction amongst the SMEs has been to attempt to decrease their machine set-up or change-over times, and to computerise their operations; this was reported by thirty-five percent of the suppliers.

(3) The suppliers believed that the extent of Prestwick's influence on their decision cited in sub-paragraph b. above was eleven percent. Other factors, including capital requirements, condition of the economy and of the industry were more important in making their decision for faster change-over machines or computerisation of their manufacturing.

(4) The general increase in global competition has been the major stimulus reported by the SMEs for accepting smaller orders more frequently. As discussed in Chapter Four, many of the SMEs have been struggling with the traditional method of producing larger batch sizes, and then holding the undelivered excess in inventory to meet the smaller, more frequent, deliveries required by Prestwick. This traditional manufacturing method is diametrically opposed to the desired

JIT goal of manufacturing smaller batches on a more frequent basis, ideally reducing inventories to zero.

e. Increased design and engineering services and contract administration responsibilities requested by Prestwick and implemented by the SMEs:

(1) Ninety-four percent of the SMEs received, or were aware of other companies who had received, requests by Prestwick for design or professional engineering services involved in the procurement process.

(2) Sixty-two percent of the suppliers had responded by increasing their CNC-to-conventional machinery ratio, or by adding CAD/CAM capabilities to their firms. One firm had taken the first step towards a CIM system, whilst several others were planning to implement CIM within two years.

(3) Firms without in-house engineering capabilities have been turning to outside professional engineering consultants, thus utilising a specialty resource to remain competitive. Chapter Six discusses a firm that achieved steady growth by providing this service as well as by competing in machine shop and general engineering areas.

(4) The respondents rated Prestwick's influence at twenty-four percent of all factors involved in their decisions to make changes described above. This influence does indicate significant symbiosis between the component suppliers and Prestwick.

(5) The mutuality of this change has been evidenced by the increasing use, during the past three years, of supplier design by Prestwick. An alternative, not chosen, would have been for Prestwick to increase its in-house engineering and design staff. This increased use of suppliers' skills and services, even to the extent of providing office facilities at Prestwick, indicates a mutual symbiont relationship and supports the contention that direction of benefit flow or causality is not important.

f. Changes in product liability to the ultimate end-user extending to the SME component supplier attempted by Prestwick (former

procedure was for component supplier to warrant the part or component until it became an integral part of the aircraft, thence the major manufacturer was responsible to the end-user):

(1) Ninety-one percent of the respondents observed that there were increased expectations from Prestwick to be responsible directly to the aircraft purchaser for product warranties and liabilities. Several of the firms experienced requests for defective product replacement beyond the stated warranty period.

(2) Ninety-four percent of the SMEs had a written guarantee for their product, or included a warranty period in the written contract. This guarantee generally ended after the component had been accepted through quarantine by Prestwick.

(3) The attempt by Prestwick to extend the warranty to the ultimate user indicates a symbiont relationship with the SMEs. Prestwick has been attempting to make the major component suppliers realise that their ultimate responsibility lies with the customer, not just with the major manufacturer. Prestwick's objective is to build a feeling of partnership between Prestwick and the SMEs, so both believe that they are involved with the final product. Chapter Three discusses this changing relationship more fully.

(4) The negative reaction to this change does not provide a significant influence rating by Prestwick upon the SMEs.

g. Stocks - JIT manufacturing technique of minimal or JIT inventory stockage reflected in reduced stockage levels by Prestwick and the corresponding impact or effect upon the SMEs:

(1) Ninety-seven percent of the respondents believe that Prestwick had reduced its stocks significantly during the previous three years.

(2) Twenty-nine percent of the suppliers responded by reviewing their procurement policies and stock levels, and adopted procedures for just-in-time delivery to Prestwick.

(3) Prestwick took the initiative in this area by making significant stock reductions, followed by smaller-sized purchase orders, along with requiring more frequent delivery schedules. This had an initial predicted negative effect upon the suppliers, but aided the Prestwick buyers in determining which of the suppliers could perform under the new JIT environment.

5.0 RESEARCH LIMITATIONS

Research is by implication limited to particular situations scrutinized using specific procedures; therefore inherent limitations are to be expected.

5.1 Major Manufacturer

Only one major manufacturer was selected and used for inquiries during this research. Selection of other major manufacturers may result in different findings and conclusions. For example, Rolls Royce and Westland are two additional major aerospace manufacturers located in Britain. Each of them are unique and could have different effects upon the research data. Airbus Industrie, Boeing, and McDonnell-Douglas are the other major civil aerospace manufacturers, each of which could affect the analysis from different global or operational perspectives.

5.2 Component Suppliers

Component suppliers vary in size from extremely large, some of which are of equal size or larger than British Aerospace Plc., (e.g. IBM Corporation), to small businesses. An arbitrary decision was made to limit inquiries to component suppliers with less than £25 million in annual turnover and less than 400 employees. This definition is generally considered valid for defining small businesses both in Britain and in the U.S.A.

This size decision was made because the researcher believed it is more likely to observe symbiotic changing relationships between small businesses and a major manufacturer than between two entities of comparable size. No attempt was made in this dissertation to prove or disprove the validity of this decision. Larger component suppliers could have a different affect upon the results of this research, and therefore size must be considered a limitation.

A second decision was made to limit interviews to SMEs located geographically in Britain. The primary reason for this geographical limitation was to limit political and cultural variables as much as possible from the data gathered. Secondary reasons for geographical limits were time and financial constraints. Therefore, geographical constraints must be considered a limiting factor concerning the results of this dissertation because non-British SMEs may have a different viewpoint than the interviewees.

A third decision was made to limit sample size to an amount large enough for statistical validity, many statisticians believe samples exceeding twenty-eight become valid, yet small enough to manage within one year of field work. A disproportionate stratification sampling technique was used to select potential companies from the suppliers used by Prestwick. Thirty-four companies agreed to participate out of thirty-seven asked. This sample is obviously not the entire population serving Prestwick, therefore any conclusions drawn from these results should be restricted to the sample of thirty-four companies.

5.3 Interview Length

A multiple case study has inherent time limitations that preclude intensive or in-depth interviews being conducted as discussed in chapter

three. Because of time limitations, pertinent information could possibly be overlooked or otherwise not fully discussed. Interview time must therefore be considered a limitation as concerning the thirty-four component suppliers interviewed using the multiple case study method.

5.4 Applicability to Other Industries

This research was conducted within the civil aerospace industry in Britain during a specific period of time - 1989 through 1991. No inference is made, nor intended, that the information is applicable to other industries, nor to civil aerospace industries outside of Britain.

6.0 RECOMMENDATIONS FOR FUTURE RESEARCH

6.1 Longitudinal study

A longitudinal study is appropriate using the same questionnaire in another geographical location. Preliminary contact has been made with the Boeing Company in Seattle and a longitudinal study will be attempted utilising component suppliers to Boeing, starting after the completion of this dissertation.

6.2 'No-change' companies

A question not covered by this research is what effect the companies that are not making changes in their manufacturing, quality or purchasing systems have upon the civil aerospace industry or Prestwick. Future research could attempt to measure their impact, or lack of impact, upon the results of this dissertation.

6.3 Research Other Industries

A third area of future research would be to see if these results are applicable to other industries. There are many similarities between the aerospace industry and the electronics and automotive industries. Research in these two industries, using the same questionnaire or adapted specifically for those industries, could be informative and interesting. Other industries that encompass high degrees of technology and research and development should also be considered for similar research - metaphysics, bio-medicine, genetic engineering, pharmaceuticals and others.

6.4 Research Other Theories

This dissertation centered on the symbiotic changing relationship theory. Another theory for testing by future research could include the interaction theory favoured by marketeers. This theory examines closely the interaction relationships between the industrial consumer and the prime manufacturer, and how the relationships evolve over time. Many of the goals sought by the civil aerospace industry are included within its framework - long-term relationships, increasing dependency or feeling of partnerships, increasing communications between the interacting parties, sharing of technological advances and so forth. An argument could be raised that the interaction theory is supportive of the research already conducted in this study, and if financial resources are available, should be undertaken in the future.

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APPENDIX A

SMALL AND MEDIUM-SIZED COMPONENT SUPPLIER QUESTIONNAIRE

****

COVER SHEET

****

C2 CODE: _____

COMPANY DATA:

NAME: _____

TEL & FAX: _____

ADDRESS: _____

_____

_____

HOME OFFICE: _____

BRANCH LOCATIONS: _____

HISTORY: YEAR FOUNDED: C3 _____ # OF OWNERS: C4 _____

BEGAN EXPORTING: C5 _____ STOPPED EXPORTING: C6 _____

GENERAL DESCRIPTION OF COMPANY & PRODUCTS:

_____

_____

MEMO: _____

_____

_____

_____

_____

FIELD LOG:

1st Appt _____

In _____Out _____

2nd Appt _____

In _____ Out _____

Mailings: _____

_____

_____

NOTES:

_____

COMPANY: _____

****

PERSON INTERVIEWED: _____

****

Ô ACCOUNTING C7 POSITION: _____

Ó ENGINEERING _____

Ó GENERAL MANAGEMENT COMMENTS: _____

Ó MARKETING/SALES _____

Ó PRODUCTION _____

Ó PURCHASING _____

Ó QUALITY CONTROL _____

Ó _____ _____

C8. FLUENCY IN FOREIGN LANGUAGES SPOKEN? _____

C9. # OF BUSINESS YEARS LIVED ABROAD? _____

C10. YEARS EXPERIENCE IN THIS INDUSTRY? _____

C11. TOTAL YEARS OF BUSINESS EXPERIENCE? _____

C12. TOTAL YEARS OF EXPORT EXPERIENCE? _____

C13. # OF BUSINESS FOREIGN JOURNALS READ ON A REGULAR (OR SUBSCRIPTION) BASIS? _____

C14. # OF FOREIGN BUSINESS TRIPS ANNUALLY? _____

C15. ARE YOU FOREIGN BORN? Y N

C16. ARE YOU A FOUNDER OF THIS COMPANY? Y N

NOTES: _____

_____

_____

_____

COMPANY: _____

****

SME COMPONENT SUPPLIER QUESTIONNAIRE

****

GENERAL: OVERVIEW OF THE COMPANY AND OPERATING STRATEGIES

****

1. WHAT EXTERNAL FACTORS DO YOU FEEL MOST AFFECT THE OPERATION OF YOUR COMPANY? (i.e. Competition, Major Mfgr's, Economy etc.)

_____

_____

2. WHAT HAS BEEN THE BIGGEST CHANGE IN YOUR COMPANY DURING THE PAST THREE YEARS? _____

3. WHAT HAS BEEN THE BIGGEST CHANGE IN THE AEROSPACE INDUSTRY DURING THE PAST THREE YEARS? _____

4. OVERALL, HAVE THESE CHANGES HAD A POSITIVE / NEUTRAL / NEGATIVE EFFECT UPON YOUR COMPANY? C17

5. WHY? _____

6. YOUR GROSS ANNUAL TURNOVER (SALES): (000's)

C18	1990 PLAN:	_____
C19	1989 ACTUAL:	_____
C20	1988 ACTUAL:	_____

7. APPROXIMATE PERCENT OF CURRENT GROSS ANNUAL SALES:

C21	ALL MAJORS - ANY INDUSTRY?	_____ %
C22	AEROSPACE INDUSTRY ONLY?	_____ %
C23	EXPORT - ANY INDUSTRY?	_____ %
C24	EXPORT - AEROSPACE INDUSTRY ONLY?	_____ %

8. NUMBER OF FULL-TIME EMPLOYEES:

C25	OWNERS/MANAGERS	_____
C26	MARKETING/SALES	_____
C27	ENGINEERING/R&D	_____
C28	PRODUCTION	_____
C29	ADMINISTRATIVE	_____
C30	QUALITY ASSURANCE	_____
C31	_____	_____
C32	TOTAL CURRENT YEAR	======
C33	TOTAL PRIOR YEAR	======

9. REASON FOR CHANGE? _____

10. APPROXIMATE CURRENT REPLACEMENT VALUE OF MACHINERY AND EQUIPMENT IN-SERVICE CURRENTLY? _____ C34
11. WHAT IS YOUR PLANNED ANNUAL GROWTH RATE? _____% C35
12. AVERAGE AMOUNT OF STOCKS ON HAND? _____ C36
13. ARE YOU SEEKING MORE / SAME / LESS AEROSPACE BUSINESS? C37
14. WHY? _____

****

MANUFACTURING: SIGNIFICANT CHANGES IN PRODUCTION AND PURCHASING TECHNIQUES MADE WITHIN THE PAST THREE YEARS

****

15. HAVE YOU NOTICED ANY SIGNIFICANT CHANGES IN PRODUCTION OR QUALITY ASSURANCE METHODS BY MAJOR AEROSPACE MANUFACTURERS IN THE PAST THREE YEARS? C38 Y N
16. WHO? _____
17. WHAT? _____
18. HAS BRITISH AEROSPACE - PRESTWICK MADE ANY OF THE FOLLOWING CHANGES, AND IF SO, HOW DO THEY AFFECT YOU?

- C39 JUST-IN-TIME PROD. FAV--3--2--1--0--1--2--3--UNF
- C40 TOTAL QUALITY CONTROL FAV--3--2--1--0--1--2--3--UNF
- C41 SINGLE SOURCING FAV--3--2--1--0--1--2--3--UNF
- C42 COST/RISK SHARING FAV--3--2--1--0--1--2--3--UNF
- C43 SMALLER LOT SIZES FAV--3--2--1--0--1--2--3--UNF
- C44 SUPPLIER DESIGN/ENGR'G FAV--3--2--1--0--1--2--3--UNF
- C45 PRODUCT LIABILITY FAV--3--2--1--0--1--2--3--UNF
- C46 BAe STOCK REDUCTIONS FAV--3--2--1--0--1--2--3--UNF
- C47 _____ FAV--3--2--1--0--1--2--3--UNF

19. IS BAe CHANGING THEIR ATTITUDE CONCERNING:

C48 LONG-TERM SUPPLIER RELATIONSHIPS? (i.e. automatic renewals) FAV--3--2--1--0--1--2--3--UNF

C49 FEELING OF PARTNERSHIP WITH SUPPLIERS? FAV--3--2--1--0--1--2--3--UNF

C50 ELIMINATION OF ADVERSARIAL BUYING ROLES? FAV--3--2--1--0--1--2--3--UNF

C51 KEEPING YOU INFORMED ABOUT PRODUCTION SCHEDULES, NEW PRODUCTS ETC.? FAV--3--2--1--0--1--2--3--UNF

C52 VENDOR PAYMENT PROCEDURES? FAV--3--2--1--0--1--2--3--UNF

C53 _____ FAV--3--2--1--0--1--2--3--UNF

20. HAVE YOU MADE ANY OF THE FOLLOWING CHANGES IN YOUR PRODUCTION TECHNIQUES:

		YES	IN-PROC	N/A
C54	JUST-IN-TIME PRODUCTION?	Ó	____	Ó
C55	JIT DELIVERY PROCEDURES?	Ó	____	Ó
C56	TOTAL QUALITY CONTROL?	Ó	____	Ó
C57	STATISTICAL QUALITY CONTROL?	Ó	____	Ó
C58	FASTER MACHINE SET-UPS?	Ó	____	Ó
C59	CNC, CAD/CAM PROCEDURES?	Ó	____	Ó
C60	ROBOTICS?	Ó	____	Ó
C61	JIT PURCHASING METHODS?	Ó	____	Ó
C62	_____	Ó	____	Ó

21. HOW STRONG WOULD YOU RATE BAe's INFLUENCE ON YOUR CHANGES CHECKED ABOVE? 0 >>>>>>>>50>>>>>>>> 100

C63	JUST-IN-TIME PRODUCTION	____
C64	JIT DELIVERY PROCEDURES	____
C65	TOTAL QUALITY CONTROL	____
C66	STATISTICAL QUALITY CONTROL	____
C67	FASTER MACHINE SET-UPS	____
C68	CNC, CAD/CAM PROCEDURES	____
C69	ROBOTICS	____
C70	JIT PURCHASING METHODS	____
C71	_____	____

22. HOW OFTEN DO PERSONNEL FROM BAe - PRESTWICK REGULARLY VISIT YOUR FACILITY? (IN MONTHS) C72 ____

23. DO YOU FEEL ANY OF THE FOLLOWING ARE REASONS FOR BAe VISITS TO YOUR FACILITY?

C73	EXPEDITE PRODUCTION IN THEIR FAVOUR	Ó
C74	SOLVE YOUR QUALITY PROBLEMS	Ó
C75	RATING YOU AS A SUPPLIER	Ó
C76	TRAIN YOUR PERSONNEL	Ó
C77	MANAGEMENT FAMILIARISATION TOURS	Ó
C78	GENERAL GOODWILL/PR REASONS	Ó
C79	QUALITY ASSURANCE/VERIFICATION INSPECT	Ó
C80	_____	

24. HOW OFTEN (IN MONTHS) DO YOUR PERSONNEL REGULARLY VISIT BAe FACILITIES? C81 _____

25. WHAT ARE THE REASONS FOR YOUR VISITS?

C82 SALES/PR CALLS Ó
C83 SOLVE MUTUAL PRODUCTION PROBLEMS Ô
C84 COORDINATE PRODUCTION SCHEDULES Ó
C85 TRAINING OF YOUR STAFF Ó
C86 SEEK ASSISTANCE WITH YOUR PROBLEMS Ó
C87 LEARN ABOUT NEW PRODUCTS Ó
C88 _____

26. DO YOU GUARANTEE QUALITY? C89 N/A % PPM CONTRACT
27. WARRANTY PERIOD? C90 _____
28. PRODUCTION LEAD TIMES:
    C91 CURRENTLY _____ WEEKS
    C92 YEAR AGO _____ WEEKS
29. ARE YOUR DELIVERY DATES: C93 N/A ESTIMATED FIRM
30. # OF MISSED DELIVERY DATES? C94 _____ %
31. ARE YOU MAKING VISITS TO YOUR SUPPLIERS? C95 Y N
32. ARE YOU FORMALLY RATING YOUR SUPPLIERS? C96 Y N
33. APPROXIMATE ANNUAL PROCUREMENT AMOUNT C97 £'s _____
34. ALLOCATE 100 MARKS TO FACTORS AFFECTING YOUR SELECTION OF QUALIFIED SUPPLIERS:

C98	QUALITY	Ó	_____
C99	ON-TIME DELIVERY	Ó	_____
C100	PRICE	Ó	_____
C101	COMMUNICATION SKILLS (esp. prod probs)	Ó	_____
C102	GENERAL REPUTATION WITHIN INDUSTRY	Ó	_____
C103	TECHNICAL ASSISTANCE	Ó	_____
C104	REQUIRED BY BAe	Ó	_____
C105	_____	Ó	_____
	TOTAL		100.0

35. SOURCING INFORMATION AND EFFECTIVENESS:

C106	_____%	BRITISH
C107	_____%	EEC
C108	_____%	U.S.A.
C109	_____%	FAR EAST
C110	_____%	OTHER?
	TOTAL 100.0%	

36. PURCHASING PROBLEMS? _____

_____

37. DURING THE PAST THREE YEARS, HAVE YOU NOTICED ANY - CHANGES IN NUMBERS OF YOUR SUPPLIERS':
C111 DECREASING / SAME / INCREASING

38. WAS THIS YOUR DECISION? C112 Y N

39. CHANGES IN QUALITY BY YOUR SUPPLIERS':
C113 INCREASING / SAME / DECREASING

40. WAS THIS BECAUSE OF YOUR INSISTENCE? C114 Y N

41. CHANGES IN SUPPLIERS' MEETING PROMISED DELIVERY DATES:
C115 BETTER / SAME / WORSE

42. WAS THIS AT YOUR INSISTENCE? C116 Y N

43. COMMUNICATIONS BETWEEN YOU AND YOUR SUPPLIER:
C117 BETTER / SAME / WORSE

44. WHO INSTIGATES COMMUNICATION? C118 YOU THEM

45. HAVE YOU MADE ANY CHANGES IN YOUR PROCUREMENT PROCEDURES BECAUSE OF BAe? C119 Y N

46. WHAT? _____

****

MARKETING: SEARCHING FOR CHANGES DURING PAST THREE YEARS

****

47. HAVE YOU NOTICED ANY CHANGES IN PROCUREMENT POLICIES BY MAJOR AEROSPACE MANUFACTURERS IN THE PAST THREE YEARS?
C120 Y N

48. WHO? _____

49. WHAT? _____

50. MARKETING PROFILE:

C121	APPROX SIZE OF MARKET YOU ARE COMPETING IN?_____	
C122	TRADE SHOW PARTICIPATION	NAT'L INT'L BOTH NA
C123	MARKETING BUDGET IS	INCREASING / SAME / DECREASING
C124	COMPETITION IS	INC--3--2--1--0--1--2--3--DEC
C125	MARKET SHARE IS	INC--3--2--1--0--1--2--3--DEC
C126	DOMESTIC PROFITS ARE	INC--3--2--1--0--1--2--3--DEC
C127	EXPORT PROFITS ARE	INC--3--2--1--0--1--2--3--DEC
C128	MARKET DEPENDENCY IS	INC--3--2--1--0--1--2--3--DEC

51. COMPARISON OF BAe BUYERS TO BUYERS FROM OTHER INDUSTRIES:

C129	PROFESSIONALISM	FAV--3--2--1--0--1--2--3--UNF
C130	PROVIDE TECHNOLOGY	FAV--3--2--1--0--1--2--3--UNF
C131	SUBMIT TIMELY ORDERS	FAV--3--2--1--0--1--2--3--UNF

C132 # OF CHANGE REQUESTS FAV--3--2--1--0--1--2--3--UNF
C133 FORECASTING SKILLS FAV--3--2--1--0--1--2--3--UNF
C134 COMMUNICATION SKILLS FAV--3--2--1--0--1--2--3--UNF
C135 RESPECT LEAD TIMES FAV--3--2--1--0--1--2--3--UNF
C136 _____ FAV--3--2--1--0--1--2--3--UNF

52. METHODS OF INTERNATIONALISATION USED:

C137 BRITISH SALES AGENTS OR REPRESENTATIVES?
VE EFF AV NE VIE N/A

C138 DIRECT EXPORTING TO CUSTOMERS?
VE EFF AV NE VIE N/A

C139 FOREIGN DISTRIBUTORS OR AGENTS?
VE EFF AV NE VIE N/A

C140 FOREIGN SALES & DISTRIBUTION SUBSIDIARIES?
VE EFF AV NE VIE N/A

C141 FOREIGN MANUFACTURING FACILITIES?
VE EFF AV NE VIE N/A

C142 FOREIGN JOINT VENTURES?
VE EFF AV NE VIE N/A

C143 FOREIGN LICENSING AGREEMENTS?
VE EFF AV NE VIE N/A

C144 IMPORTING OF MATERIALS OR COMPONENTS?
VE EFF AV NE VIE N/A

C145 _____ VE EFF AV NE VIE

53. # OF COUNTRIES EXPORT AEROSPACE PRODUCTS TO? C146 _____

54. WHERE? _____

55. # OF COUNTRIES YOU EXPORT ANY PRODUCTS TO? C147 _____

56. WHERE? _____

****

ACCOUNTING: CHANGES IN THE MANAGEMENT ACCOUNTING SYSTEM

****

57. HAVE YOU NOTICED ANY CHANGES IN ADMINISTRATIVE POLICIES BY MAJOR AEROSPACE MANUFACTURERS THE PAST THREE YEARS?
C148 Y N

58. WHO? _____

59. WHAT? _____

60. DO YOU USE A COMPUTERISED ACCTG SYSTEM?
C149 YES PART NO

61. ADD'L DATA PROVIDED BY MANAGEMENT ACCOUNTING SYSTEM:

C150	QUALITY MONITORING? (i.e. # of defects)	Ó
C151	DECISION MAKING? (i.e make or buy, return on investment etc.)	Ó
C152	OPERATIONAL DATA? (i.e. # of machine set-ups, # of purchase orders processed)	Ó
C153	TOOL WEAR OR DEVIATION MONITORING?	Ó
C154	VENDOR/SUPPLIER MONITORING & RATING?	Ó
C155	PROCESS CONTROL/SCHEDULING	Ó
C156	_____	

62. STAFF CHANGES PAST THREE YEARS? C157 INC SAME DEC

63. PROFESSIONAL QUALIFICATION CHANGES? C158 INC SAME DEC

64. DO THE ACCOUNTING STAFF REVIEW ANY OF THE FOLLOWING WHEN SELECTING NEW SUB-CONTRACTORS OR SUPPLIERS?

C159	FINANCIAL STATEMENTS	Y	N
C160	MANAGEMENT ACCOUNTING SYSTEMS	Y	N
C161	FINANCIAL SOLVENCY	Y	N
C162	BID COSTING COMPILATIONS	Y	N
C163	_____		

65. ARE BUDGETS UTILISED? C164 Y N

66. HOW OFTEN ARE BUDGETS REVISED? (In months) C165 _____

67. ARE ACTUAL RESULTS COMPARED TO BUDGET? C166 Y N

68. IS CURRENT YEAR COMPARED TO PRIOR YEAR? C167 Y N

69. PROPORTION OF COST ELEMENTS TO TOTAL PRODUCT COST:

C168	DIRECT LABOUR	_____ %
C169	DIRECT MATERIALS	_____
C170	FACTORY OVERHEADS (DIRECTS)	_____
	TOTALS	100.00 %

70. BASIC COSTING METHOD CURRENTLY

		USED?	PLANNED?
C171	JOB/BATCH/CONTRACT COSTING	Ó	_____
C172	OPERATIONS COSTING	Ó	_____
C173	PROCESS/SERVICE COSTING	Ó	_____
C174	JUST-IN-TIME COSTING	Ó	_____
C175	_____	Ó	_____

71. SUPERIMPOSED COSTING TECHNIQUES:

C176	BUDGETARY CONTROLS	Ó
C177	STANDARD COSTING	Ó

C178	ACTIVITY BASED COSTING		Ó	
C179	_____			
		ABSOR-PTION	MARGI-NAL	ABC
72.	OVERHEAD ALLOCATIONS:	Ó	Ó	Ó
C180	BASED ON LABOUR HOURS	Ó		
C181	BASED ON MATERIALS COSTS	Ó		
C182	BASED ON MACHINE HOURS	Ó		
C183	UNITS OF OUTPUT	Ó		
C184	_____	Ó		

73. DESCRIPTION: _____

74. ISSUE PRICE OF MATERIALS?

C185	SPECIFIC IDENTIFICATION	Y	N
C186	FIFO/LIFO	Y	N
C187	WEIGHTED AVERAGE	Y	N
C188	_____	Y	

75.	*IF ACTIVITY BASED COSTING IS USED:	Ô	N/A
C189	HOW MANY PRIMARY DRIVERS?	_____	
C190	HOW MANY SECONDARY DRIVERS?	_____	
C191	OTHER LEVELS OF DRIVERS?	_____	
C192	REVIEWED HOW OFTEN? (# of months)	_____	

76. *IF ACTIVITY BASED COSTING IS USED, HOW ARE COST DRIVERS SELECTED? (Alternatively - what do you feel your cost drivers are?) _____

_____

77. *IF VARIABLE COSTING IS USED:

C193	FOR ALL COSTING?	Y	N
C194	SPECIAL ORDERS/CUSTOMERS?	Y	N
C195	AS A CONTROL ON COSTS?	Y	N
C196	FOR COST-BENEFIT ANALYSIS?	Y	N
C197	_____	Y	

78. *IF VARIABLE COSTING IS USED, HOW DO YOU TREAT FIXED COSTS?

C198	ALLOCATE FIXED COST TO STOCK AND COST OF SALES AT END OF PERIOD	Y	N
C199	USE VARIABLE COSTING FOR INTERIM WORK & ADJUST TO A FULL COSTING END OF PERIOD	Y	N
C200	USE A DUAL RECORD KEEPING SYSTEM	Y	N
C201	_____		

79. HOW DOES THE ACCOUNTING DEPARTMENT PARTICIPATE IN PRODUCT PRICING?

			N/A
C202	PROVIDES COST DATA ONLY	Y	N
C203	PARTICIPATES IN PRODUCT PRICING TEAM	Y	N
C204	PRIMARY PREPARER	Y	N
C205	_____	Y	

APPENDIX B

MAJOR MANUFACTURER QUESTIONNAIRE

****

MAJOR MANUFACTURER'S QUESTIONNAIRE

****

A. GENERAL MANAGEMENT - THE PURPOSE OF THIS SECTION IS TO GAIN GENERAL BACKGROUND KNOWLEDGE OF YOUR DIVISION AND TO SEARCH FOR RECENT CHANGES IN METHODS OF DOING BUSINESS.

****

A1. WHAT IS THE MANUFACTURING STRATEGY/OBJECTIVES OF THIS DIVISION? _____

A2. WHAT IS YOUR BASIC ORGANISATION STRUCTURE? _____

_____

A3. WHAT IS YOUR DESIRED RELATIONSHIP WITH COMPONENT SUPPLIERS? _____

_____

A4. WHAT METHOD/PROCEDURE DO YOU USE TO QUALIFY CAPITAL INVESTMENT OPPORTUNITIES? _____

_____

A5. WHAT DEGREE OF AUTONOMY DO YOU HAVE WITH RESPECT TO DECISION MAKING? _____

_____

A6. CEILING ON CAPITAL EXPENDITURE DECISIONS? C3 £_____

A7. WHAT EXTERNAL FACTORS AFFECT THE WAY YOUR DIVISION FUNCTIONS? _____

A8. WHAT INTERNAL FACTORS AFFECT THE WAY YOUR DIVISION FUNCTIONS? _____

A9. DURING THE PAST THREE YEARS HAVE ANY OF THE FOLLOWING CHANGES OCCURRED IN YOUR DIVISION, AND HOW SIGNIFICANT ARE THE EFFECTS ON YOUR SUPPLIERS? (VS = very significant, VIS = very insignificant.)

C4 BUSINESS PLANS AND BUDGETS, newer methodology, better forecasting techniques VS--3--2--1--0--1--2--3--VIS

C5 MANAGEMENT ACCTG REPORTS, i.e. revising or creating new management information reports to keep pace with production changes VS--3--2--1--0--1--2--3--VIS

C6 CREATION OF MULTI-DISCIPLINARY TEAMS, i.e. to review pricing, product simplification, parts reduction, supplier qualification VS--3--2--1--0--1--2--3--VIS

C7 COST CONTROLS, i.e. product line interchangeability, product simplification, parts commonality, use of standard parts VS--3--2--1--0--1--2--3--VIS

C8 SOURCING PROCEDURES, i.e. single or limited sourcing, decrease in total number of vendors VS--3--2--1--0--1--2--3--VIS

C9 SOURCING RELATIONSHIPS, i.e. plant visits to suppliers, emphasis on long-term relationships, engendering feeling of partnerships VS--3--2--1--0--1--2--3--VIS

C10 SOURCING RESPONSIBILITIES, i.e placing design responsibility or R&D at supplier level VS--3--2--1--0--1--2--3--VIS

C11 SOURCING CLASSIFICATIONS, creating a 'preferred' or certified supplier VS--3--2--1--0--1--2--3--VIS

C12 SOURCING RESTRICTIONS, not allowing suppliers to deal with competitors or to internationalise their marketing VS--3--2--1--0--1--2--3--VIS

C13 SOURCING INFORMATION, requesting/requiring detail of bid costing, financial statements, proof of solvency VS--3--2--1--0--1--2--3--VIS

C14 PRODUCTION METHODS, i.e. just-in-time manufacturing, cellular techniques, cnc, cad/cam VS--3--2--1--0--1--2--3--VIS

C15 PRODUCTION QUALITY SPECIFICATIONS, i.e. measuring in ppm, SPC utilisation, VS--3--2--1--0--1--2--3--VIS

C16 PRODUCTION LINE 'AUTHORITY', i.e. can assembly workers stop for quality problems VS--3--2--1--0--1--2--3--VIS

C17 TOTAL QUALITY CONTROL, i.e. vendor's assuming 100% tqc in-coming responsibility, vendor ratings, vendor delivery & performance measures VS--3--2--1--0--1--2--3--VIS

C18 VENDOR PAYMENT PROCEDURES, i.e. simplification of invoicing procedures, change in payment schedules VS--3--2--1--0--1--2--3--VIS

C19 INVENTORY LEVELS REDUCTION, i.e. just-in-time purchasing methods, decrease work-in-process, buffers VS--3--2--1--0--1--2--3--VIS

C20 MAKE OR BUY, increase/decrease % of components bought vs made in-house VS--3--2--1--0--1--2--3--VIS

A10. WHAT IS THE BUSINESS PLAN CONCERNING THIS NEW MODEL AND TECHNIQUES APPLICABLE TO FUTURE MODELS? _____

_____

****

B. ACCOUNTING INFORMATION - THE PURPOSE OF THIS SECTION IS TO ASCERTAIN THE MANAGEMENT ACCOUNTING METHODS USED FOR INTERNAL USE AND REPORTS.

****

B1. PLEASE DESCRIBE PRESENT MAS: _____

_____

B2. HOW LONG HAVE THE MAJOR COMPONENTS OF THIS SYSTEM BEEN IN PLACE? C21 _____

C22 _____

C23 _____

B3. PLEASE ASSIGN TOTAL OF 100 MARKS TO THE FOLLOWING NONFINANCIAL DATA PROVIDED BY YOUR PRESENT MAS SYSTEM:

C24	QUALITY MONITORING, # of defects, failures	_____
C25	DELIVERY DATA, # of on-time	_____
C26	DECISION MAKING, make or buy, roi, irr	_____
C27	OPERATIONAL DATA, # of machine setups, # of purchase orders, materials handling	_____
C28	TOOL WEAR/DEVIATION MONITORING	_____
C29	VENDOR MONITORING/RATING	_____
C30	PROCESS CONTROL/SCHEDULING	_____
C31	_____	_____
	TOTAL	100.00

B4. ACCOUNTING RELATIONSHIPS WITH COMPONENT SUPPLIERS:

C32 DETAILED COSTING OF SUBMITTED BIDS? N/A Ó
VIM--3--2--1--0--1--2--3--VUP

C33 INSPECTION OF VENDOR ACCOUNTING RECORDS DURING PLANT VISITS OR RATING PROCEDURES? N/A Ó
VIM--3--2--1--0--1--2--3--VUP

C34 YOU PROVIDE TRAINING OF THEIR ACCOUNTING PERSONNEL OR USE OF YOUR ACCOUNTING SOFTWARE? N/A Ó
VIM--3--2--1--0--1--2--3--VUP

C35 VERIFICATION OF AMOUNT OF 'CUSTOMER DEPENDENCY' LIMITATIONS IMPOSED BY YOUR DIVISION? N/A Ó

VIM--3--2--1--0--1--2--3--VUP

C36 LIMITATION AMOUNT OF TOTAL TURNOVER? _____ %

C37 PROOF OF FINANCIAL SOLVENCY OR STABILITY? N/A Ó

VIM--3--2--1--0--1--2--3--VUP

B5. RANKING OF 'VENDOR PARTNERSHIP' FACTORS: N/A RANK

C38 DO YOU PROVIDE VENDORS WITH COST DATA? Ó _____

C39 DO YOU PROVIDE OPERATING OR EQUIPMENT ACQUISITION LOANS TO VENDORS? Ó _____

C40 DO YOU OFFER EXCESS COMPUTER TIME? Ó _____

C41 ARE VENDORS CHARGED A FEE FOR SERVICES? Ó _____

C42 ARE OPEN ENDED PURCHASE AGREEMENTS USED IN LIEU OF SPECIFIC PURCHASE ORDERS? Ó _____

C43 _____ _____

TOTAL MARKS 100.0

B6. IS YOUR COMPUTERISED ACCOUNTING SYSTEM LINKED TO THE PRODUCTION/DESIGN COMPUTERS? C44 Y N

B7. HOW IS COSTING INCORPORATED INTO YOUR PRODUCT PRICING PROCEDURES? _____

B8. PLEASE APPROXIMATE THE PROPORTION OF EACH COST ELEMENT TO TOTAL PRODUCTION COSTS:

C45 DIRECT LABOUR _____ %

C46 DIRECT MATERIALS _____

C47 DIRECT PRODUCTION OVERHEADS _____

C48 INDIRECT NON-PRODUCTION OVERHEADS _____

TOTALS 100.00 %

B9. BASIC COSTING METHOD CURRENTLY: USED? PLANNED?

C49 JOB COSTING Ó _____

C50 OPERATIONS COSTING Ó _____

C51 PROCESS COSTING Ó _____

C52 JUST-IN-TIME COSTING Ó _____

C53 _____ Ó _____

B10. SUPERIMPOSED COSTING TECHNIQUES:

C54 BUDGETARY CONTROLS Ó _____

C55 STANDARD COSTING Ó _____

C56 ACTIVITY BASED COSTING Ó _____

C57 _____ Ó _____

			ABSOR-PTION	MARGI-NAL	ABC
B11.	DIRECT PRODUCTION COSTS:		Ó	Ó	Ó
	C58 BASED ON LABOUR HOURS	Ó			
	C59 BASED ON MATERIALS COSTS	Ó			
	C60 BASED ON MACHINE HOURS	Ó			
	C61 BASED ON UNITS OF OUTPUT	Ó			
	C62 _____	Ó			
B12.	INDIRECT PRODUCTION:		Ó	Ó	Ó
	C63 BASED ON LABOUR HOURS	Ó			
	C64 BASED ON MATERIALS COSTS	Ó			
	C65 BASED ON MACHINE HOURS	Ó			
	C66 UNITS OF OUTPUT	Ó			
	C67 _____	Ó			
B13.	SERVICE COSTS: (i.e. canteen, rep)		Ó	Ó	Ó
	C68 _____	Ó			
B14.	HOW ARE MATERIAL COSTS DETERMINED?				
	C69 INVOICE PRICE			Y	N
	C70 ADDITIONS FOR FREIGHT, INSURANCE ETC			Y	N
	C71 ADDITIONS FOR OVERHEADS			Y	N
	C72 _____				
B15.	ISSUE PRICE OF MATERIALS?				
	C73 SPECIFIC IDENTIFICATION			Y	N
	C74 FIFO/LIFO			Y	N
	C75 WEIGHTED AVERAGE			Y	N
	C76 _____				
B16.	*IF STANDARD COSTING IS USED, HOW ARE THE STANDARDS DETERMINED?				
	C77 BY INDUSTRY 'PUBLISHED' STANDARDS			Y	N
	C78 CURRENT TIME/MOTION STUDIES			Y	N
	C79 TARGET OR IDEAL STANDARDS			Y	N
	C80 _____			Y	N
B17.	*HOW OFTEN ARE THESE STANDARDS REVISED?				
	C81	N/A M Q SA AN ____			
B18.	*IF ACTIVITY BASED COSTING IS USED:				
	C82 HOW MANY PRIMARY DRIVERS?			_____	
	C83 HOW MANY SECONDARY DRIVERS?			_____	

C84 OTHER LEVELS OF DRIVERS? _____

C85 REVIEWED HOW OFTEN? (# of months) _____

B19. *IF ACTIVITY BASED COSTING IS USED, METHOD USED TO SELECT COST DRIVERS? _____

B20. *IF VARIABLE COSTING IS USED:

C86 FOR ALL COSTING? Y N

C87 ONLY FOR SPECIAL ORDERS? Y N

C88 AS A CONTROL ON COSTS? Y N

C89 FOR COST-BENEFIT ANALYSIS? Y N

C90 _____ Y N

B21. *IF VARIABLE COSTING IS USED; HOW DO YOU TREAT FIXED COSTS?

C91 ALLOCATE FIXED COST TO STOCK AND COST OF SALES AT END OF PERIOD Y N

C92 USE VARIABLE COSTING FOR INTERIM WORK & ADJUST TO A FULL COSTING END OF PERIOD Y N

C93 USE A DUAL RECORD KEEPING SYSTEM Y N

C94 _____

B22. WHEN COMPUTING MAKE OR BUY CALCULATIONS:

C95 ARE OVERHEADS FULLY ABSORBED? Y N

C96 ARE OPPORTUNITY COSTS CONSIDERED? Y N

C97 ARE UNDERUTILISED ASSETS CONSIDERED? Y N

C98 ARE 'SOCIAL' FACTORS CONSIDERED? i.e. ease of decreasing suppliers vs workforce etc. Y N

C99 _____

B23. HAS YOUR ACCOUNTS PAYABLE PROCEDURES CHANGED DURING THE PAST THREE YEARS:

C100 VENDOR RESPONSIBLE FOR DELIVERY DOC'S? Y N

C101 MORE FREQUENT INVOICING BY VENDORS? Y N

C102 MORE FREQUENT PAYMENTS DISBURSED? Y N

C103 DOCUMENTATION SIMPLIFIED? Y N

C104 INTEGRATED INTO VENDOR 'RATING' PROGRAM? Y N

C105 _____

B24. WHAT IS THE AVERAGE TIME-SPAN FROM RECEIPT OF A BONE-FIDE VENDOR INVOICE UNTIL PAYMENT IS MADE? C106 ____ DAYS

B25. WHAT ARE YOUR AVERAGE INVENTORY LEVELS:

C107 COMPONENTS AND RAW MATERIALS? £ _____

C108 RIP OR WIP? £ _____

C109 FINISHED GOODS? £ _____

B26. ARE THERE OTHER ACCOUNTING FACTORS THAT COULD AFFECT THE COMPONENT SUPPLIERS THAT HAVE NOT BEEN DISCUSSED?

B27. TYPE OF BUDGETS PREPARED? C110 N/A FIX FLEX

B28. TIME PERIOD BUDGETED? (in months) C111 _____

B29. ACTUAL RESULTS COMPARED TO BUDGET? C112 Y N

B30. PRIOR YEAR RESULTS COMPARED TO CURRENT? C113 Y N

B31. HOW OFTEN ARE BUDGETS REVISED? (In months) C114 _____

B32. WHO HAS AUTHORITY TO REVISE BUDGETS? _____

B32. WHO HAS AUTHORITY TO FLEX BUDGETS? _____

****

C. PROCUREMENT POLICIES - THE PURPOSE OF THIS SECTION IS TO REVIEW THE POLICIES AND PROCEDURES CURRENTLY IN USE BY YOUR PURCHASING DEPARTMENT AND THE METHOD USED FOR SELECTION OF NEW SUPPLIERS.

****

C1. WITHIN THE PAST THREE YEARS HAVE YOU SWITCHED TO SINGLE OR LIMITED SOURCE PROCUREMENT METHODS? C115 Y N

C2. IF YES, HAS THIS RESULTED IN:

C116 REDUCING SUPPLIERS BY _____ %

C117/8 TOTAL NUMBER OF SUPPLIERS FROM_____ TO _____

C119 MAINTAINING CONTACT WITH 'BACK-UP' SUPPLIERS, 'JUST IN CASE'? Y N

C120 GIVING BACK-UP SUPPLIERS SMALL ORDERS TO REMAIN IN TOUCH? Y N

C121 CREATING HARD-FEELINGS AMONG SUPPLIERS NOT SELECTED? Y N

C122 CREATING A THIRD TIER OF SUB-CONTRACTORS TO THE PRIMARY SUPPLIERS? Y N

C3. WAS THIS SWITCH PART OF A CHANGE TO JUST-IN-TIME OR SIMILAR NEW METHOD OF MANUFACTURING? C123 Y N

C4. OVERALL, WHAT ARE YOUR PURCHASE LEAD TIMES:

C124 RAW MATERIALS? ____ WEEKS

C125 COMPONENTS? ____ WEEKS

C5. HOW ACCURATE ARE YOUR FORECASTS FOR:

C126 RAW MATERIALS VA--3--2--1--0--1--2--3--VIA

C127 COMPONENTS? VA--3--2--1--0--1--2--3--VIA

C6. HAVE YOU BEEN REDUCING IN-PROCESS AND SUB-ASSEMBLY INVENTORY LEVELS AT YOUR FACILITIES? C128 Y N

C7. HOW? _____

C8. HAVE RELATIONSHIPS WITH COMPONENT SUPPLIERS CHANGED IN ANY OF THE FOLLOWING WAYS:

C129 YOUR STAFF MAKING ROUTINE LIAISON VISITS? Y N

C130 YOUR EXPERTS VISITING AS PROBLEMS OCCUR? Y N

C131 PERIODIC VERIFICATION OF 'ABILITY TO PERFORM' BY ON-SITE AND/OR SUBMISSION OF FINANCIAL DATA, REPORTS OR BONDING. Y N

C132 CLOSER, LONG-TERM RELATIONSHIPS Y N

C133 FEELING OF CO-OPERATION, MUTUAL PROBLEM SOLVING ATTITUDE Y N

C134 REDUCTION OF THEIR ABILITY TO EXPORT Y N

C135 REDUCES THEIR ABILITY TO SELL TO OTHER DOMESTIC COMPETITORS Y N

C136 PROBLEMS SURFACE QUICKER WHEN USING SINGLE SOURCING Y N

C137 SIMPLER ADMINISTRATION & PAPERWORK Y N

C138/9 PENALTIES ARE/SHOULD BE IMPOSED FOR LATE DELIVERY Y N

C140/1 VENDOR IS/SHOULD BE RESPONSIBLE FOR TQC Y N

C142 RETURN SPECIFIC DEFECTIVE ITEMS ONLY Y N

C143 ONE DEFECT = RETURN ENTIRE LOT Y N

C144 CONTINUOUS RATING OF VENDORS DELIVERY & QUALITY PERFORMANCE Y N

C145 REQUIRE NEARBY WAREHOUSING BY VENDORS @ THEIR EXPENSE Y N

C146 VENDOR DELIVERY OF PARTS ONTO ASSEMBLY LINE Y N

C9. DO THE ABOVE ANSWERS APPLY 'ACROSS THE BOARD' FOR ALL VENDORS, OR ARE SOME DIFFERENT THAN OTHERS? _____

C10. ARE REORDERS PUT OUT TO BID OR PREVIOUS SUPPLIER ASKED ONLY? C147 BOTH BID PREV N/A

C11. EXPLAIN: _____

C12. ARE THERE ANY RESTRICTIONS PLACED ON YOUR

SUPPLIERS AS TO EXPORTING OR SELLING TO YOUR COMPETITORS OF NON-PROPRIETARY ITEMS? C148 Y N

C13. WHAT? _____

C14. SELECTION OF SUPPLIERS: (please allocate 100 marks)

C149	PRICE?	_____
C150	QUALITY? (PPM REG'D _____ C45)	_____
C151	ON-TIME DELIVERY?	_____
C152	DELIVERY TO LINE?	_____
C153	SMALL-ORDER CAPABILITIES?	_____
C154	REACTION TO CHANGE REQUESTS?	_____
C155	FRIENDLINESS OF SALES STAFF?	_____
C156	RESPONSE TO PROBLEMS?	_____
C157	GENERAL REPUTATION WITHIN INDUSTRY?	_____
C158	TECHNICAL ASSISTANCE AVAILABLE?	_____
C159	_____	_____
	TOTAL MARKS	100.0

C15. ARE SUPPLIER'S RESTRICTED AS TO AMOUNT OF THEIR PRODUCTION THAT CAN BE SOLD TO YOU? C160 Y N

C16. LIMITATION AMOUNT OF ANNUAL TURNOVER? C161 _____ %

C17. SOURCING OF COMPONENTS AND SUB-ASSEMBLIES: (BY % OF TOTAL VALUE)

C162	OUT-SOURCED - DOMESTIC	_____%
C163	OUT-SOURCED - IMPORTED	_____
C164	AFFILIATES/SUBSIDIARIES	_____
C165	MADE IN-HOUSE	_____
C166	_____	_____
	TOTAL	100.0%

C18. COMPOSITION OF COMPONENT SUPPLIERS:

C167 % OF SMALLER SIZED COMPANIES TO TOTAL OUT-SOURCE: (≤500 employees &/or ≤£25 million annual turn). _____%

C168 ESTIMATE OF SUPPLIERS CERTIFIED FOR NON-INSPECTION OF DELIVERY: _____%

C169 ARE YOU ENCOURAGING YOUR SUPPLIERS TO BE MORE DEPENDENT UPON YOU? Y N

C170 DO YOU GIVE FINANCIAL ASSISTANCE TO SUPPLIERS FOR CAPITAL INVESTMENTS? Y N

C171 DO YOU 'SECOND' NEAR-RETIREMENT

EXECUTIVES TO ASSIST SUPPLIERS? Y N

C172 ARE YOU REQUIRING SUPPLIERS TO DO MORE RESEARCH AND DEVELOPMENT WORK? Y N

C173 DO YOU REQUIRE SUPPLIERS TO HAVE BACK-UP SPARES READILY ACCESSIBLE TO THE ASSEMBLY LINE? Y N

C174 ARE YOU REQUIRING SUPPLIERS TO DESIGN THEIR OWN COMPONENT OR SUB-ASSEMBLY FROM SPECIFICATIONS RENDERED BY YOU? Y N

C175 SHARING OF SPECIAL TOOLING COSTS? Y N

C176 WHO OWNS SHARED TOOLING? BAe SUP

C19. ARE YOU FORMING TEAMS TO INSPECT NEW SUPPLIERS FOR QUALIFICATION? C177 Y N

C20. DO THE TEAMS ALSO INSPECT EXISTING SUPPLIERS FOR RATING PURPOSES? C178 Y N

C21. WHICH METHODS OF IN-COMING TRANSPORTATION DO YOU USE FOR RAW MATERIALS AND COMPONENTS:

C179	VENDOR SUPPLIED	____	%
C180	AIR TRANSPORT	____	
C181	GROUND TRANSPORT	____	
C182	SEA TRANSPORT	____	
C183	_____	____	
	TOTAL	100.0%	

C22. COUNTRY OF PURCHASE OF MATERIALS AND COMPONENTS:

C184	BRITISH	____	%
C185	U.S.A.	____	
C186	E.E.C.	____	
C187	FAR EAST	____	
C188	_____	____	
	TOTAL	100.0%	

C23. HOW MANY PART NUMBERS DO YOU BUY? C189 _____

C24. HOW MANY SUPPLIERS CURRENTLY? C190 _____

C25. HOW MANY WHEN JIT PURCHASING FULLY IMPLEMENTED? _____

C26. WHAT IS THE ANNUAL 'TURNOVER' OF SUPPLIERS?
i.e. those disqualified or newly qualified C192 _____

C27. ARE THERE OTHER PROCUREMENT CHANGES THAT HAVENOT BEEN DISCUSSED? _____

****

D. PRODUCTION METHODS - THE PURPOSE OF THIS SECTION IS TO DETERMINE IF ANY CHANGES IN PRODUCTION METHODS OR QUALITY CONTROLS HAVE RESULTED IN POTENTIAL 'DOWNSTREAM' CHANGES BY COMPONENT SUPPLIERS.

****

D1. GENERAL DESCRIPTION OF PRODUCTION FACILITY: _____

D2. WHAT IS YOUR CURRENT CAPACITY UTILISATION? _____ %

D3. WORKERS:

C193 ARE THEY UNIONISED? Y N

C194 ARE THEY FLEXIBLE BETWEEN MACHINES? Y N

C195 DO THEY CROSS-TRAIN? Y N

C196 AUTHORISED TO STOP ASSEMBLY LINE? Y N

D4. HOW ACCURATE ARE THE DIVISION'S SALES FORECASTS OVER THE NEXT TWO YEARS? C197 VA--3--2--1--0--1--2--3--VIA

D5. WHAT ARE AVERAGE MACHINE SETUP TIMES? C198 ____ HRS

D6. DO YOU MAKE OR BUY YOUR TOOLING? C199 BOTH MAKE BUY

D7. IF BOTH, WHAT PERCENT IS BOUGHT? C200 ____ %

D8. DO YOU SHARE TOOLING COSTS WITH COMPONENT SUPPLIERS? C201 Y N

D9. IF YES, WHO OWNS THE TOOLING? C202 BAe SUP

D10. HOW COMMON IS THIS? _____

D11. HOW OFTEN ARE CHANGE ORDERS IMPOSED? C203 _____ DAILY

D12. CHANGES ORDERS RECEIVED AS A PERCENT OF TOTAL:

C204	FROM AIRCRAFT PURCHASER	____ %
C205	FROM IN-HOUSE ENGINEERING	____
C206	FROM !N-HOUSE MARKETING/OTHER	____
C207	FROM REGULATORY/SAFETY AGENCIES	____
C208	SUGGESTIONS FROM SUPPLIERS	____
C209	_____	____
	TOTAL	100.0%

D13. PROPORTION OF COMMON/SIMILAR PARTS WITH DIFFERENT PARTS NUMBERS? C210 VG--3--2--1--0--1--2--3--VB

D14. DURING THE PAST THREE YEARS HAVE YOU CHANGED TO ANY OF THE FOLLOWING, AND INTENSITY OF THE EFFECTS OF THE CHANGES HAVE FLOWED 'DOWNSTREAM' TO YOUR COMPONENT SUPPLIERS? (VLA=very large affect; VIA = very insignificant affect on suppliers.)

C211 CAD/CAM EQUIPMENT? VLA--3--2--1--0--1--2--3--VIA

C212 LINE AUTHORISATION FOR HALTS DUE TO QUALITY OR BACK-UP PROBLEMS? VLA--3--2--1--0--1--2--3--VIA

C213 LINE RESPONSIBILITY FOR QUALITY CONTROL? VLA--3--2--1--0--1--2--3--VIA

C214 VENDOR RESPONSIBILITY FOR QUALITY CONTROL? VLA--3--2--1--0--1--2--3--VIA

C215 DATA LINKS BETWEEN LINE EQUIPMENT AND ACCOUNTING OR OTHER DEPARTMENTS? VLA--3--2--1--0--1--2--3--VIA

C216 DELIVERY DIRECTLY TO LINE BY SUPPLIERS? VLA--3--2--1--0--1--2--3--VIA

C217 INSPECTION FREE CERTIFICATION OF SUPPLIERS? VLA--3--2--1--0--1--2--3--VIA

C218 SMALLER LOT SIZES, MORE FREQUENT DELIVERY? VLA--3--2--1--0--1--2--3--VIA

C219 _____ VLA--3--2--1--0--1--2--3--VIA

D15. HOW DO COMMUNICATE THESE CHANGES TO VENDORS? _____

D16. DO YOU RECEIVE FEEDBACK ABOUT THESE CHANGES FROM YOUR SUPPLIERS? Y N

D17. DO YOU MAKE PERIODIC INSPECTIONS OF YOUR SUPPLIER'S PRODUCTION FACILITIES AS PART OF THEIR RATING AND CONTINUING EVALUATION? C220 Y N

D18. DO YOU SHARE ANY MANUFACTURING FACILITIES OR EQUIPMENT WITH SUPPLIERS? C221 Y N

D19. DO YOU ASSIST YOUR SUPPLIERS IF THEY ARE HAVING TECHNICAL OR PRODUCTION PROBLEMS? C222 Y N

D20. DO YOU INITIATE THIS ASSISTANCE? C223 Y N

D21. ARE SUPPLIERS BECOMING MORE WILLING TO HELP WITH YOUR PRODUCTION PROBLEMS? C224 Y N

D22. ARE SUPPLIERS MAKING PRODUCT IMPROVEMENT RECOMMENDATIONS MORE FREQUENTLY THAN BEFORE? C225 Y N

D23. ARE SUPPLIERS VISITING YOUR FACILITY TO LEARN ABOUT NEW PRODUCTS OR PROCEDURES? C226 Y N

D24. HAVE RECENT CHANGES IN INTERNAL MANAGEMENT REPORTS GIVEN YOU MORE USEFUL OPERATING DATA? C227 Y N

D25. IS THIS DATA CURRENT ENOUGH FOR DAY TO DAY DECISION MAKING? C228 Y N

D26. DO YOU MAINTAIN ANY COSTING OR OTHER TYPES OF ACCOUNTING DATA ON YOUR OWN (COMPUTER) THAT IS NOT PREPARED BY THE ACCOUNTING DEPARTMENT? (Request copies of reports, worksheets etc.) C229 Y N

D27. WHY? _____

D28. DOES THE ACCOUNTING DEPARTMENT RESPOND TO REQUESTS FOR NEW INFORMATION IN A TIMELY MANNER? C230 Y N

D29. HOW MUCH OF YOUR TIME IS IN ATTENDANCE IN GENERAL PLANNING MEETINGS (NON-DEPARTMENTAL). C231 ____%

D30. ARE THERE ANY SIGNIFICANT PRODUCTION PROCEDURES OR CHANGES THAT COULD AFFECT COMPONENT SUPPLIERS THAT WE HAVEN'T DISCUSSED?

APPENDIX C

SUMMARY OF COMPONENT SUPPLIERS INTERVIEWED

SUMMARY OF FIRMS INTERVIEWED

A. GENERAL

B. FINDINGS

1. General overview of the firms

   Table One - Respondents Profiles

   Table Two - Operating Profiles

   Table Three - Number of Employees

2. Factors Affecting Operations

   Table Four - Endo- and Exogenous Factors

3. Scope of Operations

   Table Five - Analysis of Annual Turnover

   Table Six - Sourcing

   Table Seven - Supplier Changes

C. CAPSULE SUMMARIES OF THE THIRTY-FOUR RESPONDENTS

SUMMARY OF FIRMS INTERVIEWED

A. GENERAL

Thirty-four component suppliers to Prestwick were interviewed during the field research portion of this dissertation. These companies were located throughout Scotland and England, partly because of World War II dispersion policies.

A comprehensive questionnaire was administered by the same researcher to the respondents, using semi-structured interview techniques. The interviews were conducted at the premises of the interviewee, and were frequently followed by plant tours and informal conversations with line personnel or managers of various departments.

B. FINDINGS

1. General overview of the firms

The tables below present a general overview of the responding companies managerial and operating profiles:

Table One - Respondents' Profiles

Interviewee's Position	General Mgr 71 %	Marketing 15 %	Production 11 %
Experience in Current Industry	≤ 10 Years 29 %	10 to ≤ 20 Years, 27 %	Largest Group 30 Yrs, 21 %
Type of Ownership	Closely Held 29%	PLC's & Sub -sidiaries, 71%	
Year Founded	≤ 1900 9 %	≤ 1955 50 %	< 1970 79 %

a. Interviewee Position

The current job classification of the interviewees are seventy-one percent general managers, fifteen percent marketing managers, and eleven percent production or engineering managers. Of the general managers, a clear majority have progressed through the engineering or production professions. This profile is of the prime interviewee, in many cases a second or third manager would also be present, usually either production or marketing.

b. Interviewee Experience

The average experience within the particular industry of the company is nineteen years, compared to an average of twenty-six years total business experience. Four interviewees have less than twenty years business experience. The average export experience is sixteen years, with three respondents not having previous export experience.

c. Ownership

Amongst the companies interviewed, twenty-nine percent are closely held limited companies. The others are either subsidiaries of larger corporations, or PLC's with ownership more widely held. Seven companies, which previously were closely held, had been bought out within the past three years. Two of the interviews were with new management that had been in place less than twelve months after the buy out. Six (18%) of the respondents are the original founder of the company.

The second area of review in this section is the operating profiles of the responding firms. The amount of equipment used, average inventories that are necessary to keep on hand, the planned annual growth rate, and the time it takes to manufacture a component, and the responsive to JIT manufacturing as measured by on-time delivery are also measured.

Table Two - Operating Profiles

	Mean	Smallest	Largest
Equipment Fair Market Value (000's)	2,540	60	20,000
Average Closing Stocks (£000's)	667	1	3,600
Planned Annual Growth Rate	12.3%	.0%	25%
Average manufacturing lead time	8 weeks	1 week	57 weeks
Lead time one year ago	10 weeks	1 week	72 weeks
Late deliveries	16 %	10 %	50 %

a. Equipment values

The amount of property, plant and equipment on hand is an indicator of size and capacity of the interviewees. The largest facility visited had approximately £20,000,000 equipment value, with the smallest having £60,000. These amounts indicate one of the deterrents to entering civil aerospace contract work - the large initial investment in highly specialised equipment. Even amongst the smaller shops the owner or manager would display their newest CNC or multi-turrented equipment with pride.

Comments were often made that this was the key to survival - CNC, multi-tooling, quick change-over.

b. Average inventories

The average stocks on hand are another indicator of the capital investment needed by aerospace component suppliers. The average was £667,000, with the largest firm having £3,600,000 ending inventories.

c. Annual growth

The responses to their planned annual growth rates resulted in an array of interesting answers. The majority of firms ranged from ten to fourteen percent, with a mean of twelve percent. This seemed realistic in the current economy and increasing competitive environments. However, several firms stated that their goal was in excess of twenty percent, one even at twenty-five percent, and they fully expected to achieve it. Their reasoning was that the civil aerospace market was an an all-time high in order books, military aerospace would decline, and that British manufacturing would be enhanced by the 1992 common market unification.

d. Manufacturing lead times

One of the indicators to symbiotic change is the differences in the amount of time from receipt of an initial order to first delivery from one year to the next. The average respondent improved their lead times from ten weeks to eight weeks during this research period. This is even more of an improvement when the fact that several of these firms are also beginning to accept design and engineering responsibilities, which adds to the time frame.

e. Late deliveries

Another factor of symbiotic change is just-in-time delivery by the component suppliers, which is a necessary element of changing to JIT production by Prestwick. The SMEs' managers were asked how many of their scheduled deliveries were on-time, regardless of the problem causing the delay. The average missed their delivery schedules by sixteen percent, with the worst case having fifty percent late deliveries. Many managers expressed concern about these relatively high percentages, and often accepted the blame within their own operation, although other exogenous factors contributed.

The third area of review in this section is an analysis of the number of employees, including owners/management, by job description for the respondents.

Table Three -Number of Employees

	Mean	Smallest	Largest
Owners or General Managers	7	1	30
Marketing and sales	4	0	44
Engineering and R&D	6	0	40
Production	77	7	280
Administrative	10	1	52
Quality Assurance	5	0	30
Others - stores, drivers etc.	1	0	42
Total Current Year	117	10	400
Total Prior Year	115	7	375

The total number of employees have remained nearly constant, but they have handled more volume. Management states that the volume increase is handled by computerisation of equipment, cross-training of production workers to handle several tasks, and breakdown of traditional demarcation rules. Several engineering firms commented that one skilled employee can set-up and monitor several CNC machines, especially those with multiple tool magazines and machining turrets. One engineering firm has successfully left CNC machines untended overnight to perform lengthy processes. An additional benefit of multi-tasking for the employees is increased job satisfaction and pride. Several of the workers told the researcher that they felt their prestige was enhanced by a JIT environment.

2. Factors affecting operations

The second general area of findings determines management's perspectives of external and internal factors affecting their operations and strategic planning. This review includes the effects of market strategies and competition, exporting, and then an analysis of annual turnover.

The first section analyzes management's perspectives of exo- and endogenous factors affecting their operations: market share, competition, domestic and export profits, and dependency upon one or few prime manufacturers.

These results are tabulated below in table four.

Table Four - Management's perspectives of exogenous and endogenous factors affecting their company

	Very Large	Large Decrease	Decrease	Equal	Increase	Large Increase	Very Large
Market Share	0	0	1	6	11	13	3
%'s	0%	0%	3%	18%	32%	38%	9%
Competition	0	2	1	18	9	4	0
%'s	0%	6%	3%	53%	27%	12%	0%
Profit	0	1	3	12	8	6	4
%'s	0%	3%	9%	35%	24%	18%	12%
Export Profits	0	1	4	13	3	4	1
%'s	0%	3%	12%	38%	9%	12%	3%
Dependency	2	5	7	15	0	2	3
on fewer Co's	6%	15%	20%	44%	0%	6%	9%

a. Market share changes

When asked about their share of the civil aerospace market, a surprising seventy-nine percent of the respondents felt their market share was increasing, with three percent experiencing a decrease. This may be partially explained by the increased need for BSA 5750 certification, which takes several years for newcomers to the market to obtain, thus limiting new competitors in the short term.

b. Competition changes

Paradoxically, thirty-eight percent of the respondents expect an increase in competition, compared to nine percent experiencing a decrease. This conclusion first appears to be a dichotomy to their market share change. This partially may be explained by recent entrants in the market from foreign competitors, and a recent surge in certification of new suppliers domestically.

Prestwick's policy of assisting suppliers to become certified in the future will influence this outcome also.

c. Profit changes - domestic

A total of fifty-three percent of the respondents have experienced increases in profits. This may may partially be explained by shifting to aerospace work from automotive or electronic, which has lower profitability margins traditionally.

d. Profit changes - export

Increases in export profits have been experienced by twenty-four percent of the respondents, reflecting a tighter market from far eastern competitors, as well as the traditional European competition. The smaller percentage may also reflect the additional costs in obtaining foreign business, including attendance at trade shows and foreign airshows. It must also be mentioned that twenty-four percent of the companies do not export at all, which implies potentially lucrative markets not being considered by these component suppliers.

e. Market dependency

Many of the companies are making vigorous efforts to become less dependent upon a few large manufacturers. Of the total, forty-one percent are becoming less dependent, with only fifteen percent becoming more dependent. One respondent's short term policy is to increase his dependency in order to develop the expertise and production knowledge from a specific contract, with a long term goal of then marketing this expertise to other companies and industries. Many companies have explicit policies of limiting their percentage of turnover to any one company, although they admit that in any short-term situation this self-imposed restriction is ignored for valid business reasons.

3. Scope of operations

The third general area establishes the scope of operations and production implications. Operating summaries of the participants include an analysis of annual turnover, sourcing locations and changes in suppliers.

Table Five - Analysis of annual turnover

	Mean £ 000's	Minimum £ 000's	Maximum £ 000's
Sales - 1990, or current fiscal year	5,520	250	60000
Sales - 1989, or prior fiscal year	4,946	230	54000
Sales - 1988, or second prior year	4,272	100	45000
% of turnover sold to major mfgr's	77%	10%	100%
% of turnover sold to civil aerospace	53%	8%	100%
% of aerospace turnover exported	11%	0%	60%
More/same/less aerospace business	more	more	same

a. Sales

Sales have increased consistent with the planned growth rate of twelve percent. Sales increased on average sixteen percent from 1988 to 1989, and twelve percent from 1989 to 1990.

b. Turnover to major manufacturers

The percentage of turnover sold to major manufacturers of all industries averaged seventy-seven percent, with the remaining going to smaller component suppliers and manufacturers.

c. Turnover within civil aerospace

The mixture of sales is changing towards more aerospace work by the respondents. Fifty-three percent on average of the annual turnover is currently sold to civil aerospace manufacturers of all sizes.

d. Turnover exported

Direct exporting is relatively a minor amount of many of the companies annual turnover, averaging eleven percent. Several managers commented that they were aware of their product being incorporated into other assemblies that were directly exported, but they were not involved in the export process itself.

e. Type of business sought

The question was asked of the respondents as to what type of new business they were seeking. The intent of this question was to determine beneficiality of their symbiont change relationship with Prestwick, although this was not expressed to the respondent. Eighty-eight percent responded with more, with the remaining twelve seeking the same amount of aerospace work. Not one respondent was making a conscious effort to decrease their aerospace work.

The second summary of this section is an analysis of the sourcing location for the SMEs suppliers.

Table Six - Sourcing

	Mean	Minimum	Maximum
UK Suppliers (May be imports)	85 %	30 %	100 %
EEC Suppliers	6 %	0 %	50 %
U.S.A. Suppliers	6 %	0 %	60 %

A frequent comment is that foreign (e.g. EEC and U.S.A.) aerospace markets are difficult to break into, with many years effort necessary to obtain the first order. Yet paradoxically, a majority of the SME's do not purchase

outside of Britain, possibly failing to capitalise on networking benefits resulting from these relationships.

The third summary of this operating section is an analysis of the changes being requested or imposed on their suppliers by the respondents.

Table Seven - Supplier changes

	Increasing	Same	Decreasing
Number of Suppliers Utilised	21 %	50 %	29 %
Quality Standards	41 %	59 %	0 %
On-time deliveries	47 %	38 %	14 %
Communication skills	35 %	56 %	9 %

Although many of the SME's do not believe they have significant influence over their raw materials suppliers, many of whom are global conglomerates, they do believe that quality and delivery is improving because of their efforts. Several state that since they have started communicating the results of their ratings to the suppliers they have been getting better response times.

BAe influences - When asked if changes had been made to their procurement system because of various influences by Prestwick, twenty-nine percent responded affirmatively. This response must be considered in overall context however, as this influence is partly related to the high technical standards required by BAe and the aerospace industry in general.

C. CAPSULE SUMMARIES OF THE THIRTY-FOUR RESPONDENTS

1. Prestonpans, Scotland: Sheet metal forming and chassis shop, and light engineering. Founded 1987; three years experience in aerospace. £600,000 annual turnover; twenty percent aerospace. Nineteen full-time employees. Approximately £250,000 equipment value. Prefers aerospace work because of quality demands. Sources 100% from British suppliers.

2. Stockton on Tees, Cleveland: Engineering firm. Founded in 1878, has operated within aerospace industry and exporting longer than interviewee has been employed (27 years). £10 million annual turnover, forty-five percent aerospace. 180 full-time employees. Approximately £20 million equipment value. Prefers aerospace work because it is a growth

area that the firm wants to be involved in. Sources 55% from British suppliers.

3. Welwyn, Garden City, Hertford. Molded plastic shapes and engineered parts. Founded 1935; 'many' years of aerospace work. £13 million annual turnover, fifteen percent direct aerospace, additional parts are known to go onto components that are for aerospace work. 300 full-time employees. Approximately £4 million equipment value. Prefers aerospace work because of industry growth. Sources 80% from British suppliers.

4. Oxford. Crew seats, cabin bulkheads, flexible cabin modules. Founded 1989, continuously worked in aerospace industry. £450,000 annual turnover, one-hundred percent aerospace. 16 full-time employees. Approximately £60,000 equipment value. Prefers aerospace work because they have developed a niche market within the aerospace industry. Sources 90% from British suppliers.

5. Slough. Engineering firm. Founded 1930; many years of aerospace experience. £9 million annual turnover, ninety percent aerospace. 220 full-time employees. Approximately £4 million equipment value. Prefers aerospace because it is profitable and a niche market. Sources ninety percent from British suppliers.

6. Wokingham. Universal joints. Founded 1930; probably started with aerospace work. £1,700,000 annual turnover, sixty percent aerospace. 60 full-time employees. Approximately £2 million equipment value. Prefers aerospace work because it is an opportunity to develop niche markets. Sources eighty-five percent from British suppliers.

7. Marlborough. Builds airframe jigs and machined parts. Founded 1966, began by making tooling for BAe. £3,720,000 annual turnover, ninety percent aerospace. 110 full-time employees. Approximately £2 million equipment value. Considers aerospace tooling a niche market. Sources 75% from British suppliers.

8. West Bromich. Spring manufacturer for automotive, heavy equipment and aerospace industries. £4 million annual turnover, eleven percent aerospace. 200 full-time employees. Approximately £1,100,000 equipment value. Believes aerospace springs is a mature market. Sources 95% from British suppliers.

9. Worley. Forging and heat treating. £12 million annual turnover, 100% aerospace. 240 full-time employees. Approximately £2

million equipment value. Specializes in aerospace industry, branching into racing engines. Sources ninety percent from British suppliers.

10. Clevedon. Founded in the 1940's. High performance and high-volume, standard off-the-shelf bearings. £6,500,000 annual turnover, seventy-five percent aerospace. 180 full-time employees. Approximately £2,200,000 equipment value. Prefers aerospace work because volume bearings are too competitive. Sources 95% from British suppliers.

11. Cheltenham. Switches, wiring blocks and harnesses and indicators. Founded in 1955. £14 million annual turnover, sixty-five percent aerospace. 250 full-time employees. Approximately £2 million equipment value. Deliberately seeking civil aircraft market to become less dependent upon military aviation. Sources 83% from British suppliers.

12. Cheltenham. Subcontract engineering firm, specialising in aluminum extrusions. £1 million annual turnover, forty percent aerospace. 23 full-time employees. Approximately £750,000 equipment value. Desires to become less dependent upon aerospace work, predicts slow-down within a few years. Sources 95% from British suppliers.

13. Leominster. Founded 1965. Communication antenna's for aircraft. £4 million annual turnover, 100% aerospace. 100 full-time employees. £500,000 approximate equipment value. Seeks more aerospace work as they have a niche market. Sources ninety percent from British suppliers.

14. Redditch. Aerospace fasteners. £9 million annual turnover, 100% aerospace. 220 full-time employees. Approximately £1 million equipment value. Sources 95% from British suppliers.

15. Redditch. Engineering firm, specialising with CNC machine shop. £7 million annual turnover, eighty percent aerospace. 95 full-time employees. £2 million approximate equipment value. Predicts slow-down in growth of aerospace industry, trying to develop other markets. Sources fifty percent from British suppliers.

16. Castle Donnington. Aircraft interior finishing service. £25 million annual turnover, sixty percent new work, remainder refurbishing older airliners. 400 full-time employees. Approximately £10 million equipment value. Sources 75% from British suppliers.

17. Whetstone. Precision CNC engineering firm. £3 million annual turnover, seventy-five percent aerospace. 80 full-time employees. Approximately £2 million equipment value. Previous experience has been

in aerospace so attempts to develop this market niche. Sources 80% from British suppliers.

18. Bilborough. Spring manufacturer. £4 million annual turnover, twenty percent aerospace. 120 full-time employees. Approximately £2 million equipment value. Not seeking a higher percentage of aerospace work. Sources 80% from British suppliers.

19. Nottingham. Surface coatings. £2 million annual turnover, eight percent aerospace. 75 full-time employees. Approximately £2,500,000 equipment value. Sources 100% from British suppliers.

20. Hull. Precision engineering firm. £3 million annual turnover, ninety-two percent aerospace. 57 full-time employees. Approximately £2 million equipment value. Prefers aerospace work because it is more profitable and longer term. Sources 30% from British suppliers.

21. Hull. Helicoil fasteners. £4,500,000 annual turnover, fifteen percent aerospace. 76 full-time employees. Approximately £1,500,000 equipment value. Seeking further aerospace business by developing a product in high demand for aircraft. Sources 85% from British sources.

22. East Retford. Rubber mouldings. £1,500,000 annual turnover, 10 percent aerospace. 62 full-time employees. Approximately £500,000 equipment value. Hesitant to seek more aerospace work because they are too small to service the industry. Sources 100% from British sources.

23. Shildon. Paint and surface coatings. £12 million annual turnover, fifty percent aerospace. 204 full-time employees. Approximately £2,225,000 equipment value. Developing contacts with American aerospace customers. Sources ninety percent from British suppliers.

24. Port Glasgow. Connectors. £60 million annual turnover, ten percent aerospace. 134 full-time employees. Approximately £7 million equipment value. Finds aerospace work more profitable than automotive, but less profitable than electronics industries. Sources eighty percent from British suppliers.

25. Altrincham. Manufacturing new aircraft windows and refurbishing used cockpit and passenger windows. £250,000 annual turnover, ninety-three percent aerospace. 10 full-time employees. Approximately £200,000 equipment value. Sources 100% from British suppliers.

26. Hazel Grove. Heat treatments and brazing. £1,200,000 annual turnover, 10% directly aerospace work, possible other subcontracted

jobs are also aerospace. 21 full-time employees. Approximately £400,000 equipment value. Sources 100% from British suppliers.

27. Stockport. Industrial and aircraft tooling maker. £3 million annual turnover, eighty-five percent aerospace. 63 full-time employees. Approximately £4 million equipment value. Sources 100% from British suppliers.

28. Washington Tyne and Ware. Precision engineering firm. £2 million annual turnover, eighty-five percent aerospace. 63 full-time employees. Approximately £2 million equipment value. Sources 100% from British suppliers.

29. Thornliebank, Glasgow. Accessory control systems and aircraft components. £600,000 annual turnover, seventy-five percent aerospace. 22 full-time employees. Approximately £500,000 equipment value. Sources forty percent from British suppliers.

30. Thornliebank, Glasgow. Machined components and avionics. £5 million annual turnover, forty-five percent aerospace. 98 full-time employees. £1 million approximate equipment value. Sources 100% from British suppliers.

31. Bellshill. Vacuum furnaces and heat treatments. £10 million annual turnover, thirteen percent aerospace. 102 full-time employees. £4 million approximate equipment value. Sources eighty percent from British suppliers.

32. Nerston, East Kilbride. Tool making, machining, electronics. £800,000 annual turnover, ten percent aerospace. 20 full-time employees. £450,000 approximate equipment value. Sources fifty percent from British suppliers.

33. Musselburgh. Wire products and specialty steel working. £13 million annual turnover, ten percent aerospace. 358 full-time employees. £20 million equipment value. Seeking more aerospace work, but concerned about 'fly-by-wire' Airbus A320 innovations. Sources ninety percent from British suppliers.

34. Glenrothes. Subcontract precision engineering, specialised welding and CAD/CAM programming services. £4,200,000 annual turnover, forty percent aerospace. 120 employees. Approximately £6 million equipment value. Prefers aerospace work over oil industry, more predictable and more profitable. Sources eighty-five percent from British suppliers.

APPENDIX D

STATISTICAL ANALYSES

APPENDIX D - **STATISTICAL ANALYSES**

1. Analysis of Variance

"Analysis of variance is a technique whereby the total variation present in a set of data is partitioned into several components. Associated with each of these components is a specific source of variation, so that in the analysis, it is possible to ascertain the magnitude of the contribution of each of these sources to the total variation."[66]

The purpose of analysis of variance testing is to determine whether there are significant differences between the means of two or more population samples. The null hypothesis assumes that the population means are the same for each group or sample. To invalidate this hypothesis, the population means are compared and, if found different, the F statistic will exceed the calculated amount derived from an appropriate table.

The F statistic is the quotient of the mean of squares of the variable factor divided by the mean of squares of the random error.

The definitions used in this analysis Include:

DF = degrees of freedom
SS = sum of squares
MS = square of the mean
F = ratio of variance statistic
p = probability or likelihood of event happening
STDEV = standard deviation

It is necessary to determine the degree of independence of each of the factors so that each factor, or population mean, can be evaluated or put in perspective with the other factors involved in the symbiotic relationship. Although symbiosis can arguably be present in a dependent environment, the strength of independence increases the strength of symbiosis, if two factors are shown to be symbiont in their relationship. For example, in a dependent environment, mutuality would probably be the stronger relationship. In an independent environment, beneficiality would be emphasized more strongly.

Three general groupings of research data were tested using the analysis of variance statistical technique:

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66. Wayne W. Daniel and James C. Terrell, "Business Statistics, Basic Concepts and Methodology", Fourth Edition, Houghton Mifflin Company, Boston, 1986.

a. known changes at Prestwick;
b. SME perception of attitude changes at Prestwick; and
c. perceived influence of Prestwick changes upon similar SME changes.

2. The first analyses of variance tested was between the known changes at Prestwick.

The testing of analyses of variance between changes in Prestwick's production, total quality control, single sourcing, risk and launch cost sharing, smaller lot sizes, vendor design responsibility, vendor liability and stock reduction procedures are shown below:

SOURCE	DF	SS	MS	F	p
FACTOR	7	55.56	7.94	3.59	0.001
ERROR	264	583.26	2.21		
TOTAL	271	638.82			

BAe Change	N	MEAN	STDEV	INDIVIDUAL 95 PCT CI'S FOR MEAN BASED ON POOLED STDEV
Production	34	3.853	1.158	(------*------)
Quality	34	4.559	1.353	(------*------)
Sourcing	34	4.618	1.724	(------*------)
Cost Share	34	3.735	1.463	(------*------)
Lot Sizes	34	3.265	1.601	(------*------)
Design	34	4.353	1.495	(------*------)
Liability	34	3.618	1.415	(------*------)
Stocks	34	3.794	1.610	(------*------)
POOLED STDEV =		1.486		2.80 3.50 4.20 4.90

The above graph and analyses indicate that each of the changes observed at Prestwick have a different mean and that the 95 percent confidence level varies significantly between them. The variation is significant at an F ratio of 2.01.

The analysis F ratio of 3.59 is highly indicative of differences between the means of the eight factors listed above, thus establishing the independence between the various factors.

It has been established in this research that Prestwick is making changes in production methods to cellular and JIT manufacturing; in procurement system towards single sourcing and JIT delivery; and, in quality control systems towards line responsibility and insistence upon vendor delivering error free products.

3. The second analyses test the relationships between several of the observations made by the SMEs towards attitude changes at Prestwick.

The mean observation of attitude changes at Prestwick includes relationships with suppliers, development of partnership feelings with suppliers, buyer attitudes, scheduling skills, and changes in payment procedures.

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	p
FACTOR	4	69.76	17.44	4.85	0.001
ERROR	165	593.65	3.60		
TOTAL	169	663.41			

BAe Change	N	MEAN	STDEV	INDIVIDUAL 95 PCT CI'S FOR MEAN BASED ON POOLED STDEV
Relationships	34	4.676	1.683	(------*-----)
Partnership	34	4.382	2.045	(------*-----)
Buyers	34	3.912	1.929	(-----*------)
Scheduling	34	3.941	1.984	(-----*------)
Payments	34	2.794	1.822	(-----*-----)
POOLED STDEV =		1.897		3.0 4.0 5.0

Significance is reached at an F ratio of 2.37. These factors have significant variances in their means with an F statistic of 4.85, indicating independence between the various factors tested.

4. The third series of tests looks at the effect of known changes by Prestwick upon their component suppliers, as perceived by the management or owners of the component suppliers.

The analysis of variance tests independence between the various influences Prestwick has upon the small and medium sized component suppliers as shown below.

The factors tested include production, delivery, total quality controls, and influences upon purchasing procedures.

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	p
FACTOR	3	0.5544	0.1848	2.54	0.077
ERROR	28	2.0406	0.0729		
TOTAL	31	2.5950			

				INDIVIDUAL 95 PCT CI'S FOR MEAN BASED ON POOLED STDEV
BAe Influence	N	MEAN	STDEV	---------+---------+---------+-------
Production	8	0.0312	0.0704	(---------*--------)
Delivery	8	0.2062	0.2513	(--------*---------)
Quality	8	0.3750	0.4027	(---------*---------)
Purchasing	8	0.0875	0.2475	(--------*---------)
				---------+---------+---------+-------
POOLED STDEV =		0.2700		0.00 0.20 0.40

Statistical validity is reached at an F ratio of 2.84; therefore the results shown above are not significant, although only by a minor amount.

When the SMEs were queried as to which external factors most affected their operations, eighteen percent of the respondents rated the influence of major manufacturers as the most important factor. An additional seven percent of the SMEs rated this as the second most influential factor on their operations. This rating is not conclusive; nevertheless, when considered with the analyses above, it adds creditability to symbiont relationships between Prestwick and its component suppliers.

5. Correlation

Correlation analysis measures the strength of the association between two or more variables.

The correlation coefficient measures the strength of the linear relationship between X and Y. Statistical significance of this coefficient verifies the alternative hypotheses, and invalidates the null hypotheses.

a. Correlation of changes within Prestwick

As previously discussed, there are significant changes currently in-process at Prestwick in their manufacturing, quality, procurement and other related systems. The purpose of this particular analysis is to test for correlation between the changes, all within the major manufacturer's level, to determine whether they can be combined into, or associated with, a symbiotic environment towards the component suppliers.

The table below is not intended to represent a correlation analysis table, but rather, it represents results of significant relationships summarised from several correlation analyses.

Table One - Correlations Reaching Significance Amongst the Observed Changes at Prestwick

	BAe Production	BAe Quality	BAe Sourcing	BAe Cost Share	BAe Lot Size	BAe Design
BAe Cost Sharing with Suppliers	.602					
BAe Single Sourcing		.562				
BAe Reduction in Lot Sizes	.463	.349		.729		
BAe Vendor Design		.424	.442	.487	.377	
BAe Vendor Liability	.557	.384		.653	.554	.410
BAe Stock Reduction		.569				

n = 34 significance = + - .349 BAe = Prestwick

Changes in Prestwick's production correlate significantly with its policy changes in cost-sharing, build-lot sizes, and vendor liability. This correlation indicates a close relationship between the various elements internal to Prestwick's build programme.

Quality changes correlate with policy changes concerning single sourcing, smaller build-lot size, vendor design, vendor liability and stock reduction programmes. This correlation indicates a close relationship with the various elements concerning purchasing policies and communications with suppliers.

Single-sourcing change correlates with the policy change in vendor design, which are both related to changes in the procurement system and vendor communications.

The changes in cost-sharing correlate with the policy changes that concern smaller lot-sizes, vendor design and vendor liability. Each of these factors are concerned with changes affecting the vendor and are closely related to vendor communications as well as strategic planning policies.

Smaller build-lot size correlates directly with vendor design and vendor liability policy changes. These factors are a result of JIT

manufacturing or procedural changes and reflect changes in flexibility of manufacturing and vendor - customer relationships.

Finally, vendor design correlates with the vendor liability policy change. As vendors become more involved in the partnership-like relationship they assume more responsibility towards the customer.

Each of these associations indicates the SME awareness of changes within Prestwick itself and how they relate or associate with each other. This pattern is important to understanding how the change agents themselves affect the symbiotic relationships and eventual changes at the SME level.

b. The second correlation analysis, relative to this chapter, associates the interrelationship between the various influences that changes at Prestwick have with each other as perceived by the SMEs.

An understanding of this association is relevant because the analysis in Chapter Four deals with this influence upon changes at the SME level; therefore, the strengths and weaknesses of the influences themselves need to be understood.

Table Two below summarises the various influences and their interrelationship between the observed changes at Prestwick as perceived by the component suppliers.

Table Two - Correlation Between Prestwick's Influences as Perceived by SMEs

Changes in Prestwick's:	Perceived Production Influence	Perceived Set-up Influence	Perceived JIT Purchasing Influence
JIT Delivery Method Influence	.573		
Quality Control Influence	-.460		.376
CNC Equipment Influence		.659	.564

n = 34 significance = + - .349

The perceived influence of production changes correlates with the influence of changes in delivery methods and quality controls. The SMEs perceived that the influence of JIT manufacturing changes was closely related to influences of changes of delivery methodology and quality control techniques.

The perceived change in set-up times at Prestwick correlates with the perceived change towards CNC equipment at Prestwick, which follows the logic of adding CNC equipment to the shop floor in the first instance.

The perceived changes in purchasing methods correlate with the influence of quality changes and CNC equipment at Prestwick. Prestwick's purchasing changes reflect changed emphasis on quality; to meet these standards, CNC equipment becomes almost a necessity in the modern competitive environment.

The above correlations illustrate the fact that the perceived influences of various changes undertaken at Prestwick are interrelated and associated as illustrated above. This factor is important because the total influence of the various factors involved is important to establishing and maintaining symbiosis between the two dissimilar-sized entities.

APPENDIX E

EXECUTIVE SUMMARY OF DISSERTATION

SENT TO PARTICIPATING SMEs

EXECUTIVE SUMMARY OF DISSERTATION

(Sent to all research participants in appreciation for participating.)

This executive abstract summarises the results of an in-depth survey of thirty-four small and medium sized component suppliers to British Aerospace. The specific areas queried includes production and manufacturing methodology changes, quality control and assurance changes, purchasing-marketing interface and changes, and changes in the necessary management information systems that support these general areas. The Prestwick division of BAe is chosen because they are making significant changes utilising JIT and cellular manufacturing techniques, culture of quality, procurement policies, and administrative procedural changes.

INTRODUCTION

The purpose of this research is to ascertain if certain defined symbiotic relationships exist between small and medium sized component suppliers and a major aerospace manufacturer.

For purposes of this research, the following two definitions are used:

1. symbiosis is defined as mutually advantageous association and/or interaction between two dissimilar sized organisations; (e.g. small/medium sized component suppliers and a major aerospace manufacturer.); and

2. small and medium sized component suppliers are abbreviated to SME throughout this summary, and are defined as companies with less than 400 employees and/or less than £25 million annual turnover.

The field work consisted of personal semi-structured interviews with key personnel in thirty-four small and medium sized component suppliers, sub-assemblies, materials or other service providers to the Prestwick Division of British Aerospace. Various management personnel were interviewed in appropriate areas at British Aerospace, Prestwick.

SUMMARY OF FINDINGS:

The aim of the first series of questions is to establish the backgrounds and experience levels of the respondents.

Table of summary statistics

Interviewee's Position	General Mgr 71 %	Marketing 15 %	Production 11 %
Experience in Current Industry	≤ 10 Years 29 %	10 to ≤ 20 Years, 27 %	Largest Group 30 Yrs, 21 %
Type of Ownership	Closely Held 29%	PLC's & Sub -sidiaries, 71%	
Year Founded	≤ 1900 9 %	≤ 1955 50 %	< 1970 79 %
Major Change Within Industry	Rapid Growth 29 %	Delivered Quality 23 %	Technology & Fiscal, ea.16%
Major Change, 2nd Choice	Single Sourcing 30%	Technology 20 %	More Outsourcing 20%
External Factors	Industry Changes 21 %	Comp. & Econ. ea. 18%	Major Mfgr's 18 %
Ext. Factors 2nd Choice	Economy 25 %	Interest Rates 25 %	Government Policies 18 %
Opinion as to effect of Change's	Positive 47 %	Neutral 41 %	Negative 12 %
Foreign Languages Spoken	None 79 %	One 15 %	Two, or more 6 %
Lived Abroad for Business Reasons	Never 85 %	One Year 3 %	Two, or more years, 12 %
Foreign Business Journals Read	None 47 %	One 9 %	Two, or more 44 %
Foreign Business Travel	None 29 %	Once 9 %	Twice, + 62 %
Began Exporting	Never Exported 21%	≤ 1964 50 %	≤ 1980 58 %

1. Ownership

Amongst the companies interviewed, 29% are closely held limited companies. The others are either subsidiaries of larger corporations, or PLC's with ownership more widely held. Seven companies, which previously were closely held, had been bought out within the past three years. Two of the interviews were with new management that had been in place less than twelve months after the buy out. Six (18%) of the respondents are the original founder of the company.

2. Interviewee Position

The current job classification of the interviewees are 71% general managers, 15% marketing managers, and 11% production or engineering managers. Of the general managers, a clear majority have progressed through the engineering or production professions.

3. Interviewee Experience

The average experience within the particular industry of the company is 19 years, compared to an average of 26 years total business experience. Only four interviewees have less than 20 years business experience. The average export experience is 16 years, with only three respondents not having any previous export experience.

4. Foreign Orientation

The interviewees frequently travel abroad on business, averaging three trips annually. Approximately 20% speak one foreign language and 15% have lived abroad for business reasons. Of the total, 47% do not subscribe to foreign journals and 29% do not travel abroad for business reasons.

5. Effect of Changes

When asked what effect the changes within the aerospace industry have upon their own company, 47% of the respondents feel that overall the changes have been beneficial. Conversely, 12% feel that the overall effect is negative, and will actually hurt the industry in the long run. The more frequently mentioned negative changes are single sourcing, risk sharing requests and delayed payment schemes by the majors.

INTERVIEW FINDINGS

The respondents are queried in six general areas of their management methodology and operating strategy:

management's perspective of the BAe buyers,
exo- and endogenous factors affecting their company,
scope of operations and manufacturing methodology,
observation of changes at BAe and their reactions,
purchasing method changes, and
management information systems

1. From the perspective of the respondent's position within the company, the following questions are asked:

Comparison of the overall professionalism of BAe buyers to other buyers

Respondent's Position	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Mgr	2	3	4	6	4	3	2
Marketing	0	0	0	1	1	2	1
Production	0	1	1	0	0	0	0
Others	0	0	0	1	1	1	0
Totals	2	4	5	8	6	6	3
Column %'s	6%	12%	15%	24%	18%	18%	9%

The aim of this question was to establish a base for symbiotic feelings of partnership.

BAe Prestwick is considered more professional than other companies dealt with by 44% of the interviewees, with 32% considering them less professional. (12% positive spread.)

Comparison of the timeliness in submitting work orders by BAe buyers

Respondent's Position	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Mgr	3	4	2	8	3	2	2
Marketing	0	0	1	1	0	1	2
Production	0	0	1	1	0	0	0
Others	0	0	0	0	1	2	0
Totals	3	4	4	10	4	5	4
Column %'s	9%	12%	12%	30%	12%	15%	12%

The aim of this question was to establish a base for symbiotic relationships and mutual beneficiality.

BAe Prestwick is considered better at submitting timely purchase requests by 38% of the respondents, with 32% stating that BAe is worse than other companies dealt with. (6% positive spread.)

Number of change requests received after initial order from BAe compared to other companies

Respondent's Position	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Mgr	2	1	2	10	4	3	2
Marketing	0	0	0	4	0	0	1
Production	0	0	1	1	0	0	0
Others	0	0	0	3	0	0	0
Totals	2	1	3	18	4	3	3
Column %'s	6%	3%	9%	53%	12%	9%	9%

The aim of this question is similar matter to b. above; 30% of the respondents feel BAe Prestwick makes fewer change requests once the order is placed than other companies dealt with, with 18% feeling that they made more changes. (12% positive spread.)

Comparison of forecasting skills of BAe buyers to other buyers

Respondent's Position	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Mgr	3	0	2	10	5	3	1
Marketing	0	0	2	1	1	0	1
Production	0	0	1	1	0	0	0
Others	0	0	0	2	1	0	0
Totals	3	0	5	14	7	3	2
Column %'s	9%	0.0%	15%	41%	21%	9%	6%

The aim of this question was to establish symbiotic changes in manufacturing methodology.

BAe Prestwick is considered to have a better long-term perspective of their build needs by 35% of the respondents, with 24% feeling they are worse than other companies dealt with. (11% positive spread.)

Additional comments included that the planning purpose build window is not long enough and is subject to frequent modification. The respondents cite as a better example of long-term building windows the German aerospace companies, which often issue a three to five year build window and seemingly make fewer changes to it. (This observation was not verified as part of this research.)

Comparison of communications efforts by BAe to other buyers

Respondent's Position	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Mgr	2	1	2	9	4	2	4
Marketing	0	0	0	0	2	3	0
Production	0	0	0	2	0	0	0
Others	0	0	0	2	0	1	0
Totals	2	1	2	13	6	6	4
Column %'s	6%	3%	6%	38%	18%	18%	12%

BAe Prestwick is considered to have better overall communication skills by forty-seven percent of the respondents, compared to only fifteen percent who feel that they are worse than other companies dealt with. (thirty-two percent positive spread, best of the various factors.)

On average, BAe Prestwick regularly visits the interviewees every seven months, but the majority of these visits tend to be technical. (Engineering or production personnel). Several comments were made that buyers never come out of their office into the 'real world'. Prestwick states that they are instituting a visitation policy whereby management and buyers are making concerted efforts to visit the majority of the suppliers in the near future.

The interviewees average visiting Prestwick quarterly, with sales calls and other goodwill efforts being the major reason. Fifty per cent of the respondents report monthly visits to BAe, either at Prestwick or another location.

Comparison of BAe buyers respect for manufacturing lead times to other buyers

Respondent's Position	Highly Unfav	Very Unfav	Less Fav	Equal	More Fav	Very Fav	Highly Fav
General Mgr	3	2	1	9	4	3	2
Marketing	0	0	0	3	0	1	1
Production	0	0	1	1	0	0	0
Others	0	0	0	3	0	0	0
Totals	3	2	2	16	4	4	3
Column %'s	9%	6%	6%	46%	12%	12%	9%

BAe Prestwick is considered by thirty-two percent of the respondents to respect the component and materials lead time needs better than other companies dealt with, with twenty-one percent feeling they have less respect. (eleven percent positive spread.

2. The second general area of questioning determines management's perspective of external and internal factors affecting their operations and strategic planning.

Management's perspective of various exogenous and endogenous factors affecting their company

	Very Large Decr	Large Decr	Decr	Equal	Incr	Large Incr	Very Large
Market Share	0	0	1	6	11	13	3
%'s	0%	0%	3%	18%	32%	38%	9%
Competition	0	2	1	18	9	4	0
%'s	0%	6%	3%	53%	27%	12%	0%
Profit	0	1	3	12	8	6	4
%'s	0%	3%	9%	35%	24%	18%	12%
Export Profits	0	1	4	13	3	4	1
%'s	0%	3%	12%	38%	9%	12%	3%
Dependency on	2	5	7	15	0	2	3
fewer Co's	6%	15%	20%	44%	0%	6%	9%

When asked about their share of the market, a surprising 80% of the respondents feel their market share is increasing, with only 3% seeing a decrease. This may be partially explained by the increased need for BSA 5750 certification, which takes several years for newcomers to the market to obtain, thus limiting new competitors in the short term.

Paradoxically, the respondents see an increase in competition, with 38% seeing an increase compared to 9% experiencing a decrease. This conclusion first appears to be a dichotomy to their market share change experience explained above, but may partially be explained by recent entrants in the market from foreign competitors and recent surge in certification of new suppliers domestically.

A total of 53% of the respondents have experienced increases in profits, which may be partially explained by shifting to more aerospace work from automotive or electronic, which has lower profitability margins traditionally.

Export profits increases have only been experienced by 24% of the respondents, reflecting a tighter market from far eastern competitors as well as the traditional European competition. However, it must also be mentioned that 24% of the companies do not export at all, which implies potentially lucrative markets not being considered.

Many of the companies are making vigorous efforts to become less dependent upon a few large manufacturers. Of the total, 41% are becoming less dependent, with only 15% becoming more dependent. One respondent's short term policy is to increase his dependency in order to develop the expertise and production knowledge from a specific contract, with a long term goal of then marketing this expertise to other companies and industries. Many companies have explicit policies of limiting their percentage of turnover to any one company, although they admit that in any short-term situation this self-imposed restriction is ignored for valid business reasons.

3. The third area of questioning establishes the scope of operations and production implications. Operating summaries of the participants are:

Analysis of annual turnover

* Trimmed mean adjusts for the distortion caused by smallest & largest responses.	Trim'd Mean* £ 000's	Minimum £ 000's	Maximum £ 000's
Sales - 1990, or current fiscal year	5,520	250	60000
Sales - 1989, or prior fiscal year	4,946	230	54000
Sales - 1988, or second prior year	4,272	100	45000
% of turnover sold to major mfgr's	77%	10%	100%
% of turnover within aerospace industry	53%	8%	100%
% of aerospace turnover exported	11%	0%	60%
More/same/less aerospace business	more	more	same

Sales have increased in line with the planned growth rate of twelve percent. The mixture of sales are changing towards more aerospace work by the respondents.

Analysis of number of employees

	Trim'd Mean	Smallest	Largest
Owners or General Managers	7	1	30
Marketing and sales	4	0	44
Engineering and R&D	6	0	40
Production	77	7	280
Administrative	10	1	52
Quality Assurance	5	0	30
Others - stores, drivers etc.	1	0	42
Total Current Year	117	10	400
Total Prior Year	115	7	375

The total number of employees have remained nearly constant, but they have handled more volume. Management states that the increase is handled by computerisation of equipment, cross-training of production workers to handle several tasks, and breakdown of traditional demarcation rules.

General summaries

	Trim'd Mean	Smallest	Largest
Equipment Fair Market Value (000's)	2,540	60	20000
Planned Annual Growth Rate	12.3%	0.0%	25%
Average Closing Stocks (£000's)	667	1	3,600
Have aerospace companies changed production methods?	yes	yes	no
Average manufacturing lead time	8 weeks	1 week	57 weeks
Lead time one year ago	10 weeks	1 week	72 weeks
Late deliveries	16 %	10 %	50 %

4. The fourth area of questioning establishes the observation of change at BAe by the SME management. In addition, for symbiosis of change to occur, there must be a reaction to these observed changes.

Has BAe Prestwick made any of the following changes, and if so, how do they affect you?

BAe changes observed by SME Component Suppliers	Unfav <<<<<<<<<<< 0 >>>>>>>>>>> Fav 1 2 3 4 5 6 7
JIT Production Methods	4.0 >>>>>>>>>>>>>>>>>
Total Quality Control	4.6 >>>>>>>>>>>>>>>>>>>
Single Sourcing	4.8 >>>>>>>>>>>>>>>>>>>>
Cost/Risk Sharing	3.8 <<<<<<<<<<<<<<
Smaller Lot Sizes	3.3 <<<<<<<<<<<<
Supplier Design & Eng'r	4.5 >>>>>>>>>>>>>>>>>
Supplier Prod. Liability	3.7 <<<<<<<<<<<<<
BAe Stock Reductions	3.8 <<<<<<<<<<<<<<
Long Term Relations	4.8 >>>>>>>>>>>>>>>>>>>
Feeling of Partnership	4.5 >>>>>>>>>>>>>>>>>
Adverse Buying Attitude	3.9 <<<<<<<<<<<<<<
Production Schedules	4.0 >>>>>>>>>>>>>>>>
Vendor Payt Procedures	2.7 <<<<<<<<<

Has the SME component supplier made any of the following changes?

	No	Partly	Yes
JIT Production Methods	53%	30%	18%
JIT Delivery Procedures	41%	21%	38%
Total Quality Control Methodology	23%	44%	32%
Statistical Quality Control Techniques	53%	26%	21%
Faster Machine Set-up Times	65%	18%	18%
CNC Equipment, CAD/CAM Methods	38%	24%	38%
Robotics or CIM Manufacturing	94%	-0-	6%
JIT Purchasing Methods	50%	38%	12%

5. The fifth area of change questions what changes have the SME's made in their purchasing methods. This is considered one of several methods used to triangulate their responses to verify the existence of symbiosis. The SME responses to changes with their suppliers include:

Visits - seventy-four percent of the SME's are now visiting their suppliers at least once annually. Fifty-six percent use some sort of a formal rating system. These internal records rate supplier delivery and quality, but are not necessarily shared with the suppliers. Both of these changes have been significantly implemented within the past three years.

Sourcing

*Trimmed mean adjusts for the distortion caused by the largest and smallest responses.	Trim'd Mean*	Minimum	Maximum
UK Suppliers (May be imports)	85 %	30 %	100 %
EEC Suppliers	6 %	0 %	50 %
U.S.A. Suppliers	6 %	0 %	60 %

A frequent comment is that foreign (e.g. EEC and U.S.A.) aerospace markets are difficult to break into, with several years effort necessary to obtain the first order. Yet paradoxically, these same SME's do not purchase outside of Britain, possibly failing to capitalise on networking benefits resulting from these relationships.

Supplier changes

	Increasing	Same	Decreasing
Number of Suppliers Utilised	21 %	50 %	29 %
Quality Standards	41 %	59 %	0 %
On-time deliveries	47 %	38 %	14 %
Communication skills	35 %	56 %	9 %

Although many of the SME's do not believe they have significant influence over their raw materials suppliers, many of whom are global conglomerates, they do believe that quality and delivery is improving because of their efforts. Several state that since they have started communicating the results of their ratings to the suppliers they have been getting better response times.

BAe influences - When asked if any changes had been made to their procurement system because of various influences by BAe, 29% respond affirmatively. This response must be considered in overall context however, as some of this influence is related to the high technical standards required by BAe and the aerospace industry in general.

6. The last area queried includes the managerial information system in existence at the SME level. Management was queried to what changes they have observed at BAe and what changes have been made in response to these observations.

The SME's have observed changes in administrative policies by BAe Prestwick and other BAe sites, with 69% responding affirmatively. The majority feel that payment slow-down is the major negative administrative change, especially at some BAe sites such as Chester. Other comments noticed a positive reduction in paperwork as group wide certification inspections become more fully implemented.

The majority of companies, 69%, utilise a computerised accounting system, with an additional 19% using partially computerised accounting procedures.

A clear majority of 88% of the companies prepare annual budgets, but only half of these are revised either annually or semi-annually.

Production costs

	Trim'd Mean	Smallest	Largest
Direct Labour	28 %	10 %	60 %
Direct Materials	31 %	5 %	67 %
Applied Overheads	40 %	16 %	70 %

The most common method of costing issued materials is the specific identification method, used by 75% of the respondents, with a moving weighted average method used by 15% of the respondents.

Accounting systems - the majority of the existing accounting systems use the traditional costing techniques of applying overheads either by direct labour hours or machine hours. Standard costing is frequently used, but is updated only annually so production management is operating with obsolete information. Several of the companies are considering updating their systems using a form of activity based costing to obtain more accurate cost data, but have not actually implemented the system as of the interview date. The overall impression of the current systems in place is that they basically meet the internal needs of management and need drastic updating.

CONCLUSION

The small and medium sized component suppliers are in the process of changing their production methods, their marketing/purchasing techniques, and to a limited degree, their management accounting systems.

How many of these changes are direct reactions to similar changes at British Aerospace is difficult to discern. The respondents attribute varying degrees of influence from BAe, varying from as little as 3% in production methods to as much as 37% for changes in quality control procedures.

The implications are that there is a symbiosis existing between the two dissimilar sized firms.

The 'majority' profile of management interviewed includes a general manager position, nearly twenty-six years business experience, does not speak a foreign language sufficiently for business purposes, reads at least

one foreign journal, travels abroad at least twice a year for business reasons, and is familiar with export procedures.

The company profile consists of one-third closely held ownerships, market share is increasing, competition is increasing, profitability is increasing and they are becoming less dependent upon one or two major manufacturers. Average turnover exceeds £5 million with 117 employees. Replacement value of equipment averages £2.5 million, closing stocks average £667,000 and the planned annual growth rate exceeds 12%. During the past three years, 47% are implementing some type of JIT manufacturing methods, 59% are willing to deliver smaller lots more frequently, 77% have improved their quality control methods and 62% have installed CNC equipment.

Management's perspective of BAe Prestwick, compared to other companies dealt with, includes:

44% believe them to be more professional,

30% believe BAe makes fewer change requests to existing orders

35% believe BAe has a better long-term build programme,

47% perceive better communication skills, and

32% believe BAe respects their lead times more.

Procedural changes are being made with their suppliers by the SME's, with 29% decreasing their supplier base, moving towards limited sourcing. Single sourcing is still viewed with apprehension. Management is pressuring suppliers to keep their deliveries on-time, 47% reporting increasing success, and 35% feel that suppliers have increased their communication skills and are willing to keep the SME's informed of supply situations and price changes. Perhaps the weakest element in the SME's procurement system is not to source world-wide, which inhibits their network building and access to foreign sales markets.

Management seems to have a keen perspective of the general economic conditions and the peculiarities of the aerospace industry. They are also actively striving to modernise their capital equipment and production methods.

Many comments were made of their wariness to become too closely associated with one major manufacturer. Management does not trust the long-term relationships being expounded upon by the majors will really matter in times of economic downturn. They feel that outside suppliers are the first to be trimmed in terms of economic downturns, even in the short-run.

To safeguard against this belief, the majority of the SME's are striving to increase their market base, not only within the aerospace industry, but also within the closely allied (through stringent quality requirements) automotive and electronic industries.

In general, management seems confident in their ability to survive the present downturn and actually increase their order book and workforce.